GREAT BOOKS OF THE WESTERN WORLD

49

DARWIN

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION

THE DESCENT OF MAN

AND SELECTION IN RELATION TO SEX

BY CHARLES DARWIN



WILLIAM BENTON *Publisher*

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served and unfavorable ones to be destroyed The result would be the formation of a new species Here then I had at last a theory by which to work

He confided this theory to Hooker and Lyell who urged him to write out his views for publication But Darwin worked deliberately he was only half through his projected book when in the summer of 1858 he received an essay from A R Wallace at Ternate in the Moluccas containing exactly the same theory as his own Darwin submitted his dilemma to Hooker and Lyell to whom he wrote Your words have come t [illegible]

[illegible] previous year together with Wallace s essay the joint work being entitled *On the Tendency of Species to form Varieties and on the Perpetuation of Varieties and Species by Natural Means of Selection*

A year later on November 24 1859 *The Origin of Species* appeared The entire first edition of 1 2 0 copies was sold on the day of publication A storm of controversy arose over the book reaching its height at a meeting of the British Association at Oxford where the celebrated duel between T H Huxley and Bishop Wilberforce took place Darwin who could not sleep when he answered an antagonist hardly took Lyell s advice and saved both time and temper by avoiding the fray

In his work however he stayed close to his the is He expanded the material of the first chapter of the *Origin* into a [illegible]

tion to Sex (1871) Darwin fulfilled his statement in the *Origin* that light would be thrown on the origin of man and his history The *Expression of the Emotions* (1872) offered a natural explanation of phenomena which appeared to be a difficulty in the way of the acceptance of evolution His last works were concerned with the form movement, and fertilization of plants

Darwin s existence at Down was peculiarly adapted to preserve his energy and give direct order to his activity Because of his continual ill health his wife took pains to shield him from every avoidable annoyance He observed the same routine for nearly forty years, his days being carefully parcelled into intervals of exercise and light reading in such proportions that he could utilize to his fullest capacity the four hours he devoted to work His scientific reading and experimentation as well were organized with the most rigorous economy Even the phases of his intellectual life non essential to his work became as he put it atrophied a fact which he regretted as a loss of happiness Such non scientific reading as he did was purely for relaxation and he thought that a law ought to be passed against unhappy endings to n [illegible]

wa [illegible]

tha [illegible] s son Francis marvelled that he could preserve it with such an undemonstrative race as we are When he died on April 19 1882 his family wanted him to be buried at Down public feeling decreed that he should be interred in Westminster Abbey where he was laid beside Sir Isaac Newton

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But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general Laws.

WHEWELL: *Bridgewater Treatise*.

The only distinct meaning of the word 'natural' is *stated*, *fixed*, or *settled*; since what is natural as much requires and presupposes an intelligent agent to render it so, i.e., to effect it continually or at stated times, as what is supernatural or miraculous does to effect it for once.

BUTLER: *Analogy of Revealed Religion*.

To conclude, therefore, let no man out of a weak conceit of sobriety, or [illegible]

progress [illegible]

BACON: *Advancement of Learning*.

AN HISTORICAL SKETCH

OF THE PROGRESS OF OPINION ON THE ORIGIN OF SPECIES PREVIOUSLY TO THE PUBLICATION OF THE FIRST EDITION OF THIS WORK

I WILL here gi e a b ef sk tch f th p ogress of opinion on *Th Orig n f Spe es* Unt l re- t h rre t m j rity f nat ral ts be-

k hel ed that pec es und rgo mou a

mou m tues uas
as B ff n. B t as his pini ns flu t ted greatly t liff rent periods, l as he does n t ent on the ca ses r means f th transf r mation of peci s, I need n t h re e t r n details.

ing att nti n to the probab lity of all change in the ganic, as well as n the ino ganic world, being th res lt of law and n t f miracul us interpo t on. Lamarck seems to have been chi fl led to hi conclusi n n the gradual hange of pecies, by the difficulty f distin guishing peci and va ties, by the almost pe fect gradati n of f rms in certain gro ps, and by the anal gy of d mesti prod ctions W th respect to the means f n odificati l. ttrib ted som thi g to tl direct a ti n of th ph cal co d t ns f l f something to th cross f alr ady e t ng f ms, an l m ch t use a d dis se th t s, to th effects f hal t. T th latt ncy he seem to ttr but all tl e bea tif l daptati ns n n t re — h tl l g neck f tl e giraff f r

m nt anu as
prog ss, n rde t ccou t f the xist nce t th prese t l of simple producti ns, he

q ently i 1815 in the Introd ct n to his *Hist nat d maux ns rt b es* In these orks he ph ls th doctrin that ll pec es, incl din man, ar desce ded from oth pe cies. H first did the min t se ce f arous-

L
L f wr tten l y l is son, pected, as ea ly as 1 9 that what call pecies re var us d gen rat ns f th sam type. It was n t u t l 1828 that h published his con ti n that th ame f rms ha n t been perpetuated nce

I

is gi of B ff co clu the sam subject. It curi how larg ly m grandf the D Er s-mus Darw n, ticipated th vi w d erro eo gro ds I p f Lamar k hi *Zoonom* (L pp. 500– 10) p blished 1 94 Accord g t Lsid re Geoffro th re is d bt that Goeth was trem partisa f sim lar ws, as sh w th I troduct t k ritte in 1 94 d 1 95 b t not p blished t ll lo g fterwards h has po tedly remarked (*Goethe al N t rforscher* co D Karl Meding s. 34) th t th f ture quest for tur alists ll be ho for tance cattle got their horns, d t f hat th y re used It is rathe ingular instance of th man wh ch similar vi w arise t about the sam tim that Goeth Germ y D Darw in E gland, nd Geoffroy Sai t Hilaire (as shall mmediat ly see) in France, cam t th sam conclusi th rigin of pecies, the years 1 94–5

not mad for th sak of this, b t t wa th esult of accide And lik manner t the th parts hich here ppears t es st l pt t on to nd. Wherea er therefore ll thi gs t the (hat is ll the part of ne hole) happe ed lik as if they ere m l for he sak of som th ng, th se ere preserved, ha g bee pproprit ly consti- t ted by an ernal po t enty nd hatsoever things ere not h constit ted, perished, nd still peri h. W here see the pri cipl of nat ral selec- shado ed forth, but how littl Ari totl f lly apprehended the principle sho by his remarks the formation of the eeth.

the origin of all things Geoffroy seems to have relied chiefly on the conditions of life or the *monde ambiant* as the cause of change He was cautious in drawing conclusion and did not believe that existing species are now undergoing modification and as his son adds *C est donc un probleme a réserver entierement à l avenir supposé meme que l avenir doive avoir prise sur lui*

In 1813 Dr W C Wells read before the Royal Society An Account of a White female part of whose skin resembles that of a Negro but his paper was not published until his famous *Two Essays upon Dew and Single Vision* appeared in 1818 In this paper he distinctly recognises the principle of natural selection and this is the first recognition which has been indicated but he applies it only to the races of man and to certain characters alone After remarking that Negroes and mulattoes enjoy an immunity from certain tropical diseases he observes firstly that all animals tend to vary in some degree and secondly that agriculturists improve their domesticated animals by selection and then he adds but what is done in this latter case by art seems to be done with equal efficacy though more slowly by nature in the formation of varieties of mankind fitted for the country which they inhabit Of the accidental varieties of man which would occur among the first few and scattered inhabitants of the middle regions of Africa some one would be better fitted than the others to bear the diseases of the country This race would consequently multiply while the others would decrease not only from their inability to sustain the attacks of disease but from their incapacity of contending with their more vigorous neighbors The colour of this vigorous race I take for granted from what has been already said would be dark But the same disposition to form varieties still existin a darker and a darker race would in the course of time occur and as the darkest would be the best fitted for the climate this would at length become the most prevalent if not the only race in the particular country in which it had originated He then extends these same views to the white inhabitants of colder climates I am indebted to Mr Rowley of the United States for having called my attention through Mr Brace to the above passage in Dr Wells work

The Hon and Rev W Herbert afterwards Dean of Manchester in the fourth volume of the *Horticultural Transactions* 1822 and in his work on the *Amaryllidaceæ* (1837 pp 19 339) declares that horticultural experiments have established beyond the possibility of refutation that botanical species are only a higher and more permanent class of varieties He extends the same view to a

ed chiefly by ation all our

In 1826 Professor Grant in the concluding paragraph in his well known paper (*Edinburgh Philosophical Journal* vol

published in the *Lancet* in 1834

In 1831 Mr Patrick Matthew published his work on *Naval Timber and Arboriculture* in which he gives precisely the same view on the origin of species as that (presently to be alluded to) propounded by Mr Wallace and myself in the *Linnean Journal* and as that enlarged in the present volume Unfortunately the view was given by Mr Matthew very briefly in scattered passages in an appendix to a work on a different subject so that it remained unnoticed until Mr Matthew himself drew attention to it in the *Gardener s Chronicle* on April 7th 1860 The diff

repopulated at successive periods and then restocked and he gives as an alternative that new forms may be generated without the presence of any mould or germ of former aggregates I am not sure that I understand some passages but it seems that he attributes much influence to the direct action of the conditions of life He clearly saw however the full force of the principle of

ies (1836 p 147) clearly expresses his belief that varieties slowly become changed into permanent species which are no longer capable of intercrossing

Rafinesque in his *New Flora of North America* published in 1836 (p 6) as follows — All species might have been varieties once and many varieties are gradually becoming species by assuming constant and peculiar character but farther on (p 18) he adds except the original types or ancestors of the genus

In 1843-44 Pr f ssor H ld man (*Boston Journal f Nat Hist U States* ol p 468) has ably gi en th argum nts f r and g st th hypothesis f th d l pm nt and modi ficatio of species h seem to l an towards the d of chang

The *l est g s f C e tion* appeared in 1844 In the tenth and m h mpr ed ed t n (1853) the an ym tl sa (p 1 5) — Th p opos t d t rm ed n aft r much consideratio is, th t tl l f an mated be gs, from tl simpl t a d ld st up t the h ghest and most rece t, a e nd r the pro dence of God, the lts, *fi st* f an m p le hich has been imparted t th fo m f lif ad ancing th m d fin t tim s, by g n tion, through grad of ganisat n t m mati g i th h ghest d cotyled ns and v te b ta, these grade being f w i n mbe and g rally marked by int rv ls f l ar act h ch fi d to be p t cal d fficulty ascertain g ffi t es *nd* f th r imp lse co ected w th th t l fo ce t n l g, tl co se f g t to mod fy gan c truct res cco d ce w th t rn l circumst ces, a food th t re f tl hab-

progresses by dd l ps, b t th t tl ffects p od ced by th co d t ns f l f are grad al. H argues w th m h f ce g ral gr nds

woodpeck ha becom adapted t ts pec liar hal ts f lif Th w k, from ts pow rf l d brilliant t l th gh d pl g tl arh editions littl accu t kn ledg and great want of sci t f ca t mmediat ly had a ry id circulat I m p t has d celle t serv ce tl co try call g tt t tl l ject m g prej dice d th preparing tl gro d f th reception f nalo s.

I 1846 the t an geol gist M J d Omalius d H ll p l lisl ed an cell t tl h hort pape (*B llet u d l'acad y d l de* tom p 81) l p that t more probabl that w peci ha bee p l ced l y desce t tl mod f cat tl n that they ha bee se ratel cr ted tl e author first prom lg ted tl 1831

P f sor Ow n in 1849 (*Natu e of Limbs* p 86) w ote as f llows — Th arch typal d a was manif ted in the fl sh und r di rse uch mod ficat ons, upon this planet, long p o to th e i tenc of th s an mal species tl at act ally ex mplify t. To what n t ll s r secondary c uses the o d rl uccess n and pr g l p nl n m n may ha e In l

l sne l —

— c nfid n e n th co l s n that th l t yx of N w Z l nd and tl red grouse of England w r di t ct cr t ns n and fo th se lands r pe t ely Al ay ls t m y b w ll t b ar in mind that by th w d cre ation th zoolog t means process h kn s n t wh t. He mplifi s thus idea by adding that wh n ch ca as tl t of th red g use are c um ted by tl oologi t as d ce f dist ct ti n f the b l and f r ch l ls, h l fly p esses tl t he kno s n t h w the red g came to be tl e and th re lu ly gn fy g lso by th mode of xp ss g s h gn rance his b lief th t both tl l d and tl land owed tl r g n t gr t fi t C eati e C If w int p et th se se t nce g n n the sam address, e by th th r t pp a th t thi m nt phi losoph r f lt 1858 h confid ce sh k n that th Apt ryx a d tl red gr use fi t p pear d in tl ir p ecti l m h kn w n t l w o b som p ocess h kn w n t what.

Thi add ss was d l e d ft r th p pe s by Mr Wallace d myself n the O gin of Speci s, p esentl t be f rred t had been

by ch xp es ns as th continu us pe t f cre t po that I n l ded P o- fesso Ow w th th r p leo t l gi ts a b ing firmly co inced of the mm tab l ty f pecies b t t appears (*Anat f V t b at s* l p 96) that tl was n my part a p e- post ro rro In th last edit f thi k I inf rred and th inf ce till e ms to m perfectly j t, from passa b ginn g w th th ds n d bt th typ f m &c. (*ibid* l p xxx) that Prof sor O adm tt d that nat l l ct n may ha d n some- thi g th f rm t n f a n w pec b t

thus it appears (*ibid* vol iii p 798) is inaccurate and without evidence I also gave some extracts from a correspondence between Professor Owen and the Editor of the *London Review* from which it appeared manifest to the Editor as well as to myself that Professor Owen claimed to have promulgated the theory of natural selection before I had done so and I expressed my surprise and satisfaction at this announcement but as far as it is po sible to understand certain recently published pas sages (*ibid* vol iii p 798) I have either partially or wholly again fallen into error It is consolatory to me that others fin l I rofessor Owen s controversial writings as difficult to understand and to reconcile with each other as I do As far as the mere enunciation of the principle of natural selection is concerned it is quite immaterial whether or not I rofessor Owen preceded me for both of us as shown in this historical sketch were long ago preceded by Dr Wells and Mr Matthew

M Isidore Geoffroy Saint Hilaire in his lectures delivered in 18‿0 (of which a resume appeared in the *Revue et Mag de ›olog* Jan 1851) briefly gives his reason for believing that specific characters *sont fixés pour chaque es pece tant qu elle se perpétue au milieu des memes circonstances ils se modifient si les circon stances ambiantes viennent à changer* *En résumé* l ol servation *des animaux sauvages démontre déja la variabilité limitée des especes Les experiences sur les animaux sauvages de venus domestiques et sur les animaux domesti ques redevenus sauvages la démontrent plus clairement encore Ces m mes expériences prouvent de plus que les differences produites peuvent etre de* valeur g nerique In his *Hist nat generale* (tom ii p 430 18 9) he an pli fies analogous conclus ons

From a circular lately issued it appear that Dr Freke in 18‿1 (*Di bl n Medical I ress* p 3??) propounded the doctrine that all organic beings have descen led from one primor lial form His grounds of belief and treatment of the subject are wholly different from mine but as Dr Freke has now (1861) published his essay

Mr Herbert Spencer in an essay (originally

opment of organic beings with remarkal le skill an l force He argues from tl e analogy of domestic productions from the changes which the embryos of many species undergo from the difficulty of distinguishing specie and varieties and from the principle of general gradation that species have been modif ed and he attributes the modification to the change of circumstances The author (185) has also treated I sychology on the principle of the necessary acquirement of each mental power and capacity by gradation

In 18‿2 M Naudin a distingui hed botan ist expressly stated in an admirable paper on the Origin of Species (*Revue horticole* p 102 since partly republi hed in the *Nouvelles Ar chives du muséum* tom i p 171) his belief that pecies are formed in an analogous man ner as varieties are under cultivation and the latter process he attributes to man s power of selection But he does not show how selection acts under nature He believes like Dean Her bert that pecies when nascent were more plastic than at pre ent He lays weight on what he calls the principle of finality *puis sance mystérieuse ind terminée fatalité pour les uns pour les autres v lonte providentielle dont l action incessante sur les tres vivants dé termine à toutes les ép oques de l existence du monde la forme le v lume et la durée de chacun d eux en raison de sa de tinée dans l ordre de choses dont il fait partie C est cette puissance qui harmonise chaque membre à l e nsemble en l appropriant à la fonction qu il doit rempl r dans l orga ism e général de la nature fonction qui est pour lui sa raison d etre* [1]

In 18 3 a celebrate l geologist Count Key serling (*Bu lletin de la soc géolog* 2nd ser tom x p 3 7) sugge ted that as new lis ease supp e l to l ave l een caused by ome miasma have ari n an l spread over the worl l at certain per ods tl e germs of exi t ing sp ecie may have l en chem cally affecte l by circumambient molecules of a particular

nature, and thus have g n rise to n w f rms.

In this same year 1853 Dr Schaaffhausen published an xcell t pamphl t (l e l nd de Nat h st Vereins der P eu Rhe lands &c.) n hi h he maintains th d l pm t of o ganic forms the artl H inf rs that many species ha kept tru f l g periods, where as a f w ha become modified. Th distin tion of species he xplains l y th destructi n of intermediate grad ted forms. Th s li ing plants and animals are t separ ted from th extinct by n w cre ti ns, but are to be gard ed as th ir desce dants thr gh continued re prod cti n.

A well kno n Fre ch botanist, M. Lecoq, writes in 1854 (*Et des s ge g ph. bot t m* 1, p. 250) *O roit q nos echer hes la fixit la orat n de l' pece, no us cond ent directement ux idées émises par deux hommes justement célèb e G off y S nt H la r t Goethe*" Som the passages scatte ed through M. Lecoq larg w k, mak t a little d btf l h w far he tends his w on the modificati n f pecies.

The Philosoph y f C ti n h been tre ted in mast ly mann r by th R v Bad P ll, n hi *E y o the U ty f Worlds* 1855 N thing can be m re triking than th mann n wh ch he h ws th t the introd cti n f n w peci is regular n t a casual phen menon as Sir J hn H schel expresses t, a nat al n cont adistin tion to a miracul process

Th third l m f the *J nal* f th Lin nean Soci ty co tains p pers, ead July 1 t 1858, by Mr W llace and my lf in which as stated in th introd ctory remarks t this ol ume, the theory f N t ral Selecti is pro m lg ted by M Wall ce w th adm rable force and clearn ss.

Von Bae toward h m ll zool gi ts feel so prof und a respect, expressed about the year 18 9 (see Prof Rud lph Wagne *Zoologis l Intl polog sche Untersuchungen*, 1861 *i) h con cti n chiefly grounded on the* laws f geo raph cal distr but n that forms n w perfe tly distinct ha e descended from a i l p rent f rm

In June, 1859 Profe or Huxley gave a lec ture bef re the R yal In titutı n n the I er sist nt Types f Animal Life R ferring to such cases, h remarks, It is difficult to com preh nd the meani g of uch facts as the e if w s ppo e that ach peci s f anim l and plant, or ach great type f organ sation, was f med a d placed pon tl e su face of the

d t n o re clati n as t s opposed to th g n ral analogy of natu e If on th oth r hand we v w Pers t nt Types in relati n t that hypothesis which s pposes th specie l v g t any tim to be th esult of th grad

nl ne t h ch physiol gy l ds any coun

In Decembe 1859 D Hooker publ l ed h *Int oduct n t th lu t l n Flo* In th first part of this great w k he adm ts the truth of th d scent and mod ficat n f pe ci s, d upports th doctrine by ma y r g nal l rvati ns

The first editi n f th w k as published n N mbe 24th 1859 nd tl second edi ti n J nuary th 1860

When on board H M S *Beagle* as naturalist I was much struck with certain facts in the distribution of the organic beings inhabiting South America and in the geological relations of the present to the past inhabitants of that continent These facts as will be seen in the latter chapters of this volume seemed to throw some light on the origin of species—*that mystery of mysteries* as it has been called by one of our greatest philosophers On my return home it occurred to me in 1837 that something might perhaps be made out on this question by patiently accumulating and reflecting on all sorts of facts which could possibly have any bearing on it After five years work I allowed myself to speculate on the subject and drew up some short notes these I enlarged in 1844 into a sketch of the conclusions which then seemed to me probable from that period to the present day I have steadily pursued the same object I hope that I may be excused for entering on these personal details as I give them to show that I have not been hasty in coming to a decision

My work is now (1859) nearly finished but as it will take me many more years to complete it and as my health is far from strong I have been urged to publish this abstract I have more especially been induced to do this as Mr Wallace who is now studying the natural history of the Malay Archipelago has arrived at almost exactly the same general conclusions that I have on the origin of species In 1858 he sent me a memoir on this subject with a request that I would forward it to Sir Charles Lyell who sent it to the Linnean Society and it is published in the third volume of the *Journal* of that society Sir C Lyell and Dr Hooker who both knew of my work—the latter having read my sketch of 1844—honoured me by thinking it advisable to publish with Mr Wallace s excellent memoir some brief extracts from my manuscripts

This abstract which I now publish must necessarily be imperfect I cannot here give references and authorities for my several statements and I must trust to the reader reposing some confidence in my accuracy No doubt errors will have crept in though I hope I have always been cautious in trusting to good authorities alone I can here give only the general conclusions at which I have arrived with a few facts in illustration but which I hope in most cases will suffice No one can feel more sensible than I do of the necessity of hereafter publishing in detail all the facts with reference on which my conclusions have been grounded and I hope in a future work to do this For I am well aware that scarcely a single point is discussed in this volume on which facts cannot be adduced often apparently leading to conclusions directly opposite to those at which I have arrived A fair result can be obtained only by fully stating and balancing the facts and arguments on both sides of each question and this is here impossible

I much regret that want of space prevents my having the satisfaction of acknowledging the generous assistance which I have received from very many naturalists some of them personally unknown to me I cannot however let this opportunity pass without expressing my deep obligations to Dr Hooker who for the last fifteen years has aided me in every possible way by his large stores of knowledge and his excellent judgment

In considering the Origin of Species it is quite conceivable that a naturalist reflecting on the mutual affinities of organic beings on their embryological relations their geographical distribution geological succession and other such facts might come to the conclusion that species had not been independently created but had descended like varieties from other species Nevertheless such a conclusion

fied so as to acquire that perfection of structure and coadaptation which justly excites our admiration Naturalists continually refer to external conditions such as climate food &c as the only possible cause of variation In one limited sense as we shall hereafter see this may be true but it is preposterous to attribute to mere external conditions the structure for instance of the woodpecker with its feet tail beak and tongue so admirably adapted to catch insects under the bark of tree In the case of the mistletoe which draws its nourishment from certain trees which has seeds that must be transported by certain birds and which has flowers with separate sexes absolutely requiring the agency of certain insects to

bring pollen from one fl wer to th othe t is equally prepostero t account for th structure of this parasit with ts relations to several distinct organi bein s, by the ffects of xternal conditions, f hab t, or of the o- ition of the plant tself

It is, therefore f the hi h t n portance to gain clear insight int th means f modifica tion and coadaptat n. At th commencem t of m observ ti ns t seemed to m probabl that careful t d f d mesticated animals and of culti ted plants would off r th best chance of makin o t th. obscure probl m. Nor have I been disappointed in this and in all other perplexing cases I ha in ariably found that our kn wledge, mperfect thou h it l of ariati und d mesticati n, aff rded the best and safest cl I m v nture t x press my con ti n of th hi h al f uch t ies, altho gh th ha been ry com mon n ected b naturalists.

From these con d rat ns, I hall d t the first chapt f this Al tract t Variat n

portant, w shall see how gre t is th pow r of man in accum latin b his Selecti uccessi s. ht ariati ns. I w ll th n pass on to th ariabilit of speci in tat of nature b t I all, unfortunat l be compelled t treat this bject far too bri fl as t can be treated prope ly ly b giving l catal gues f facts. W all, how be nabled to d scuss hat circumstances are most f urabl to variation. In th next hapt th Stru l for Existence amongst ll rganic bein through-out th world, whi h in tabl f llow from the high geometrical rati of th ir increase ill be consid red. This is th doctrin f Mal th s pp ed t th hol animal and e-table kin ms. As man m re indi duals of ach ecies are born than can poss bl ur and as, conseq tl th re is freq nt l recurrin trugl for t ce t f ll s that a being, if t ary h sli htl in any manne profitab t tself und th com plex and sometimes arvin conditi ns f lif ill ha bette hance of rv g, and thus be nat ally elected From th tro princi ple f inheritance any selected ari t will tend to propagate ts w and modified form.

This fundame tal b ect f N tural Selection ill be treated t som le th in th fourth chapt and shall th see h w N t ural Selection almost in tably cause m ch

Extinction of the less improved f rms of life, and leads to what I ha called D erg nce of Charact In th n t hapt I hall discuss th compl x and little kn n laws of ariation

a simpl organ can be chan ed and perfected into a hi hl dev l ped being r into an l b-rat ly co tructed rgan secondl th ub-

con d th geol gical cces n of organic bein thro t tim in the tw lfth and thirteen th, th ir eographical distribution through out pace in th fourteenth, their lassifica ti n mut al affinities, both wh n mature

No on ou ht t feel urprise t much re mainin as yet un xplained in regard to the origin of species and ari t es, if h mak due allowance f our profound gnorance in regard t th mutual relat ons of the many beings which h around us. Wh can explain why on pecies ran es w d l and is ry num ous, and why an th allied species has a nar row ran and is rare Y t these relati ns are of th highest importance f th v d t rmin th present w lfare and, as I beli th f ture success and modificat on of ry inhab tant of this world. Still less d w kn w f th mu tual relations f th innum rabl inhab tants of the world durin th many past geological pochs in ts history Altho gh m h remains obscure and will lo g remain obscure I can ntertain no doubt, afte th most d liberat t dy and dispassi nat judgm nt of which I am capabl that th w which most natur alists until recentl nt rtained, and which I f rm ly t rtained—nam ly that each species has been independ ntl cre ted—is rroneous. I am full convinced that pecies are n t im m tabl b t that those belonging to what e called th sam gen ra are lineal descendants of som oth and gen rally extinct species, in th sam mann as th ackn wled ed ari t es f an n species are th descendants f that species. Furth rmore I am con inced that N tural Select on has been th most important, but not th exclusi e, means of modification.

CHAPTER I

VARIATION UNDER DOMESTICATION

Causes of Variability

WHEN we compare the indi fuals of th same ariety or b- an t of ur old r cult ated plants and animals, on of the first points hich trikes u s that th gen rally d more from ach oth r than do the indi viduals of any one species or ariety in tate of nature. And if e reflect on the ast d ver st of the plants and animals which ha e been cult ated, and hich ha e aried during all es und the ost diff rent limates an l tre tment, w are dri n to con l u that this great ariab lit d to our domest productions ha ing been raised un l co d t ons of lif t so uniform as, and som what diff t from, those t wl l th parent pec es had bee posed und ature There is, also, some probabilit in th w propou ded l v Andrew K ght, that tl ariability m y be partl connected w th ces d food It seems ear that rganic bein mu t be posed dur ng se ral ge rations t n w condit ons to cause an gre t amount of ariation and that, he the organ sat on has once begu t arr t g all co tin arvin for man gen rations. N case on record of ariabl or ganism ceasin t ary und cult t on. O oldest cult ted plants, l wh t t ll eld new n t s ldest d om t cated ani ials re t ll pal l of rap d impro t or odi ication

A far as I am l le t judge aft long t tention t the ject th cond t ons of lif ppear t act in tw s,—d rectl on th hole organisat on or on ce t in part lo d ind rectl b affecting th reprod ti t m W th re pect t the direct act on w m t l ar n ind that in ry case as Professor W ismann has lat l insis ted, d as I ha incidentall sl m work on Vari tio nder Domest catio n, th re are two f ctors namel the nature of th rganism, and th nature of the condit ons. Th forme seems t be much the more important for nearl sim ilar ariations som times arise nde as far as can judge d ssimilar cond tions and, on the the hand, dissim lar ariat ons arise u de cond tions which ppear t be arly uni form. Th ffects on the off pring are eithe d finite or ind finit They m y be considered as d fin t wh n all or nearly all the off pring of ndi d ls exposed to certain cond t ons duri g ral r rations are mod fied in the sam m t an changes w u us — d ced. Th re can, h w ver be little d ubt abo t many slight changes,—such as size from the amount of food co our from the nature of the food, thickness of the k n and hair from climat &c. Ea h of the ndless ariat ons whi h we see in th plumage of our f wls mu t ha had some fficient ca se and if the sam c n re t ct uniforml d rin long

nary t g as — — d

the insert on of minute dr p of poison b a gall-prod cing nsect how us what si gular m d ficat ons m ght result in th case of plants from a hemical hang in the nat re of th sap.

I d fi t ariabi ty is a much more com mon result of changed cond t on than definite ariab lit nd has probabl pla ed a m ore i rt t part in th form tion of ou domes-

— —

casionall ppe n th ou g of th same l tt and in seed ngs from th sam seed-cap- l At long t rvals of t m out of m d ons f i di d ls re red in th same country and fed w arl the sam food, d iat ns of tru ture so strongly pronounced as to d serve to be called monstrosit es arise but m n tros- t cann t be separated b any disti t l ne from slight ariations. All su h changes of

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indefinite ffect of th cond tions of lif on eacl indi d al organ sm, in nearl th same mann as th hill affects diff rent m n in an d finite mann ccording to th ir stat of bod, or constitut on, causing coughs or colds,

I

hich has ot in som country droop g ars true and tl w wl l has been gg ted that eti s the droop g d to dis se f tl e m sel f tl ar from tl e ls be ld m m ch alarmed, seems p b l le

Many la gul t r t some few f hich can be dml een d w ll h aft r be briefly d scussed I w ll l l ll d to l t m y be called co lated ariat n Im

m cs,

ue cua

com l l n l g t d h ad Som

ua ua s, —

(*Lachnanth*) wl ch col ed tl bo p k an l h ch ca sed tl hoof f ll b t tl bl k ari t es t drop ff and f th kers (Virg ia sq tt) l led we lect tl l lack m mbers f l tt f g as tl y k ha a good l ce f l g H l ss dog h mperf t teetl l g ha d and coarse ha red m ls pt t l as asserted l g l m p geo w th f tl n l feet ha k l t e tl te t p gec w tl l t l k t ll feet, and tl se th l g l ks l g fect H ce f man g sel t g l tl gm t g, peculiar ty l ll l t ce ta l mod fy t t nall tl part f tl tru t re owing to tl m t law f corre-lat m.

Tl rrs lts f th s, k n l t l ly l rstood la f ar t fi t ly co p le d d sif ed It w ll w rtl t le caref lly t t l tl se ral tre t ses n som of ou ld cult ted plants, as tl h ac th, potato, tl d l l a, & and t is really urpris g t t th dless points of

important f n But tl n mber and div r h t l l d t ns f tru t both

f ll t nd tl best n tl s subje t No b eeu r d bt how tr ng is th t nde y to nh r tan e th thk p od ce like h s fundam ntal bel f d bts ha e been thro n on thi prin l nly by theoret cal writ s Wh n any

l g n both

ppe n th pare t—say nce m g t se ral m ll on ind vid ls—and it ppears n th h ld th m re doctr n of chan almost comp l u to att b t ts re pp a n e to inh ta ce E ry m t h h d of case f all n m p ckly k n ha r bod s, & pp ing al m mb f tl sam f m ly If t ang and ar d iat ons f true t e ar e lly nh ted l ss trange and com m d iat n y be f eely dmitted to be h tabl I l p the correct way f w g tl wh l bject wo ld b t look at tl nl ta ce f y h ct wh t as tl rul nd n n l tance as th an mal

Th l w g rn g he tan f r the m t p rt u k w N can say why the sam pec liar ty l ffe nt d d ls f tl e sam pec s, d ff t peci s is s me-ti inh t d and som t t so why the ch ld lt n r ert ce tain char t rs to ts grandf the g andm tl r r m m te ance to wl y a pecul ar ty is oft n t ns m tted from sex t both e es, to x l m comm ly b t n t lu ly to tl l k se It i f t f som mpo ta to s, tl t pecu ha t e appear in tl e m l s f d mest b eeds r lt n transm tted tl l ly n a much gre t r d g ee to tl m l l e A m l n e important rul wh l I tl k m be tru ted, is that, t what pe od f lif peculiarity fir t ap-pe s, t t ds t ppear tl ff pring t a corr po ding g th gh som times earli r

rheumatism or inflammation of various organs

With respect to what I have called the in direct action of changed conditions namely through the reproductive system of being af fected we may infer that variability is thus induced partly from the fact of this system being extremely sensitive to any change in the conditions and partl f

uct species and that which may be ob served with plants and animals when reared under new or unnatural conditions Many facts clearly show how eminently s

an to tame an animal and few things more difficult than to get it to breed freely under confinement even when the male and female unite How many animals there are which will not breed though kept in an almost free state in their native country! This is gen erally but erroneously attributed to vitiated instincts Many cultivated plants di play the utmost vigour and yet rarely or never seed! In some few cases it has been discovered that a very trifling change such as a little more or less water at some particular period of growth will determine whether or not a plant will pro duce seeds I cannot here give the

ma s un ler confinement I may mention that carnivorous animals even from the trop ics breed in this country pretty freely under confinement with the exception of the planti grades or bear family which seldom produce young whereas carnivorous birds with the rarest exceptions hardly ever lay fertile eggs Many exotic plants have pollen utterly worth less in the same condition as in the most sterile hybrids When on the one hand we see domesticated animals and plants though often weak and sickly breeding freely under con finement and when on the other hand we see individuals though taken young from a state of nature perfectly tamed long lived and healthy (of which I could give numerous in stances) yet having their reproductive system so seriously affected by unperceived causes as to fail to act we need not be surprised at this system when it does act under confinement acting irregularly and producing offspring somewhat unlik their parents I may add that as some organisms breed freely under the mo t unnatural conditions (for instance rabbits and ferrets kept in hutches) showing that their reproductive organs are not easily affected so will some animals and plants withstand domes tication or cultivation and vary very slightly —perhaps hardly more than in a state of nature

d that all of sexual is certainly an error for I have given in another work a long list of sporting plants as they are called by gar deners —that is of plants which have sudden ly produced a single bud with a new and some times widely different character from that of the other buds on the same plant These bud variations as they may be named can be propagated by grafts offsets &c and some times by seed They occur rarely under nature but are far from rare under cult

as been known suddenly to assume a new character and as buds on distinct trees growing under different conditions have some times yielded nearly the same variety —for in stance buds on peach trees producing nectar ine and buds on common roses producin moss roses—we clearly see that the nature of the conditions is of subordinate importance in comparison with the nature of the organism in determining each particular form of variation —perhaps of not more importance than the nature of the spark by which a mass of com bustible matter is ignited has in determining the nature of the flames

Effects of Habit and of the Use or Disuse of Parts Correlated Variation Inheritance

Changed habits produce an inherited effect as in the period of the flowering of plants when transported from one climate to another With animals the increased use or disuse of parts has had a more marked influence thus I find in the domestic duck that the bones of the wing weigh less and the bones of the leg more in pro portion to the whole skeleton than do the same bones in the wild duck and

to the udders in cows and goats in coun tries where they are habitually milked in com parison with the organs in other countries is probably another instance of the effects of use Not one of our domestic animals can be named

in determining what charac ers are f g n ric value all such valuations bein t present m pirical. When t is xplained how gen ra orig nate under nature t will be seen that w ha no right t expect oft n t find a gen ric amount of diff rence in our d mesticated races.

In attempting to estimate th amount of structural difference between alli ed d mesti races, we are soon in ol ed in doubt, from not knowing whethe they are descended from one or se eral pare t species. This point if t could be leared p, would be int rest f for in stance it could be sho n that th gre hound, bloodhound, t rrie spaniel, and l ll-dog, which all know propaga th ir kind trul re the o pr of an single species, th n such facts would ha great w ht in making us doubt about th mm tal ut of th many closely allied nat ral pecies—f instance of the ma f es—inhal ting diff re t quarters of the orld. I d ot l h as w shall presently see that th whol amount f diff rence bet ee the se ral breeds of th d has been produced und domestication I beli that mall part of the difference is d to their being descended from distinct pecies. In the case of strongl marked races of som othe domesticated species, there is presumptive r en strong idence that all are descended from sin le w ld tock

It has oft bee assumed that man has chosen for domestication animals and plant having an extraordinary inhere t ten len to vary and lik wise t w th tand l rse climates. I do not d put that these capacities ha added lar l t the v of most of our domesticated productions b t how could a sa possibl know when h first tamed an animal, wether t ould ary in succeeding generations, and hethe t would ndure oth climates Has the litt arial lity of th ass and goose or the mall po of ndurance of armth by the reindee of cold b the common camel, pre ented their domestication I cannot doubt that if the animals an l plants, equal in mber t ou domesticated prod ctions, and brought t equall di rse classes and countries, re t n from a tat of nature and ould be made to breed for an e al number of generations und d mestication, they would on an rerag ary as largely as the parent species of ou xi tin domesticated productions ha aried.

In the case of most of our ancientl domesticated animals and plants, t is not possible to come to any definite conclusion, whethe th y are descended from one or several w ld species. Th argument mainly relied on by those who beli n th multipl origin of o r domestic animals is, that we find in the most ancient times, on th m numents f Egypt, and in the lake-habitations of Switze land, much di e sity n the breeds and that som of these an ci ent l sely resembl or are e n iden tic th. t c to been supposed.

Sw tzerland cult ted se eral k nds f wheat and barle th pea, tl e poppy for o l, and flax and they possessed se ral d mest cated animals. Th also carried on comm rce with othe nat ns. All thi learl hows, as Hee has remarked, that th y had t this arly ag progressed con d rabl in civilisat on and this again mplies a long continued pre ous period of less d anced civil sati n, l ring whi h th domesticated animals, kept l dif f rent tribes in diff rent di tricts, might ha e varied and gi n rise t distinct races. Since th disco ry of flint tools in th perficial formations f many parts of the world all geolog t beli that barbarian man ited at an n rmously remote period an l w know that t th present day th re is hardl a tribe so barbarous, as n t to ha d mest cated t l a t th d g.

Th origin of most of ou domesti animals will probabl for remain v gue B t I may l re tat that, looking to th domest d s of th whole world, I ha aft r a labori us collect on of all known facts, come t the con cl that sev ral wild species of Can dæ ha been tamed, and that their blood in some cases mingled togeth flows in the ins f ou domesti breeds. In regard t sheep and goat I can form n decided opinion. F om facts commun cated to me b Mr Blyth, on the habits, voice con tituti n, and truct re of the humped Indian cattle t is almost certain that th are descended from a diff re t b original stock from our European cattle and som competent judges beli that these latt ha had two or three wild prog nitors, —wheth or n t these deser to be called species. This con lusion, as w ll as that of the pecific distinction between th h mped and common cattle, may indeed, be looked pon as established by th admirable researches of Professor Rutim y r W th respect to horses, from reasons which I cannot h re gi I am

In many cases this could not be otherwise thus the inherited peculiarities in the horns of cattle could appear only in the offspring when nearly mature peculiarities in the silkworm are known to appear at the corresponding caterpillar or cocoon stage But hereditary diseases and some other facts make me believe that the rule has a wider extension and that,

I

est importance in explaining the laws of embryology These remarks are of course confined to the first *appearance* of the peculiarity and not to the primary cause which may have acted on the ovules or on the male element in nearly the same manner as the increased length of the horns in the offspring from a short-horned cow by a long horned bull though appearing late in life is clearly due to the male element

Having alluded to the subject of reversion I may here refer to a statement often made by naturalists—namely that our domestic varieties when run wild gradually but invariably revert in character to their aboriginal stocks Hence it has been argued that no deductions can be drawn from domestic races to species in a state of nature I have in vain endeavoured to discover on what decisive facts the above statement has so often and so boldly been made There would be great difficulty in proving its truth we may safely conclude that very many of the most strongly marked domestic varieties could not possibly live in a wild state In many cases we do not know what the aboriginal stock was and so could not tell whether or not nearly perfect reversion had ensued It would be necessary in order to prevent the effects of intercrossing that only a single variety should have been turned loose in its new home Nevertheless as our varieties certainly do occasionally revert in some of their characters to ancestral forms it seems to me not improbable that if we could succeed in naturalising or were to cultivate during many generations the several races for instance of the cabbage in very poor soil (in which case however some effect would have to be attributed to the *definite* action of the poor soil) that they would to a large extent or even wholly revert to the wild aboriginal stock Whether or not the experiment would succeed is not of great importance for our line of argument for by the experiment itself the conditions of life are changed If it could be shown that our domestic varieties manifested a strong tendency to reversion —that is to lose their acquired characters whilst kept under the same conditions and whilst kept in a considerable body so that free intercrossing might check by blending together any slight deviations in their structure in such case I grant that we could deduce nothing from domestic varieties in regard to species But there is not a shadow of evidence in favour of this view to assert that we could not breed our cart and race-horses long and short horned cattle and poultry of various breeds and esculent vegetables, for an unlimited number of generations would be opposed to all experience

Character of Domestic Varieties difficulty of distinguishing between Varieties and Species origin of Domestic Varieties from one or more Species

When we look to the hereditary varieties or races of our domestic animals and plants and compare them with closely allied species we generally perceive in each domestic race as already remarked less uniformity of character than in true species Domestic races often have a somewhat monstrous character by which I mean that although differing from each other and from other species of the same genus in several trifling respects they often differ in an extreme degree in some one part, both when compared one with another and more especially when compared with the species under nature to which they are nearest allied With these exceptions (and with that of the perfect fertility of varieties when crossed —a subject hereafter to be discussed) domestic races of the same species differ from each other in the same manner as do the closely allied species of the same genus in a state of nature but the differences in most cases are less in degree This must be admitted as true for the domestic races of many animals and plants have been ranked by some competent judges as the descendants of aboriginally distinct species and by other competent judges as mere varieties If any well marked distinction existed between a domestic race and a species this source of doubt would not so perpetually recur It has often been stated that domestic races do not differ from each other in character of generic value It can be shown that this statement is not correct but naturalists differ much

beak, with line of re rsed feathers down th breast and t has th hab t of continuall ex panding sl ntl the pper part of the oesoph s. The Jacobin has th f th rs so m ch reversed along the back of th neck that th y form hood and t has, proportionall to ts size longated win and tail fe th rs. The trumpeter and la gh r as their names xpress, utter a very different coo from th th breeds. The fantail has thirty or ven forty tail-feathers, instead of tw l e or fourteen—th normal umbe in all the members f th great pigeon family these f thers are k pt xpanded, and are carried so rect, that in good birds the head and tail tou h the oil gland is quite aborted. Se ral the less distinct breeds might be specified.

In the k leton of th se ral breeds, the development of th bones f th face in le gth and breadth and curvature diff rs normously The hape as w ll as the breadth and l ngth of the ramus of the low jaw varies in highly remarkable manne The ca dal and sacral vertebrae vary in umbe as does the numbe of the ribs, togeth w th their relati breadth and the presence of processes. Th size and ape of the pertures in the st rnum are high l variable so is the d gree of di rg nce and relati size of the two arms f th furcula. The proportional width of the gape of mouth, the proportional length of th lids, of th orifice of the nostrils, of th t gu (ot alw ys in strict correlation w th th le gth of beak) the size of the crop and of the ppe part of th oesophagus the d opment and bortion of the oil-gland th umbe of th primary wing and caudal feath rs the relati length of the g and tail to each oth and t the body the relati length of the leg and foot th n mb of scutellae on the toes, the dev lopment of kin bet een the toes, are all points of structure which are ariable. The period at hich the perfect plumage is acquired aries, as does the stat of th down with which the nestling birds are lothed when hatched. The sha e and size of the eggs ary The mann of ght, and in som breeds the voice and disposition, di remarkabl Lastl in certain breeds, the males and f males ha com to

h h carne th short-faced tumbler the runt, the barb, po t and fantail in the same genus m re especially as in e ch of these breeds several trul -inh rited ub-breeds, or pecies, as h w uld call th m, could be hown him.

Gre t as are the differences between the breeds of the p geon I am fully convinced that th common pinion f naturalists is correct, nam ly that all are descended from th rock p geon (*Col mba l vi*) incl din und r this t rm several geographical races or sub-species, which diffe from each ther in th most tri fling respects. As several of the reasons which have led me to this bel f are in some d gree pplicable in oth r cases, I will h re bri fly give th m. If the several breeds are n t arieties, and ha n t proceeded from the rock pigeon, they must have descended from t least seven or eight aboriginal stocks for it is impossibl t mak the present domest breeds by th crossing of an lesse numbe how f instance, could a po ter be prod ced by crossing tw breeds unless on f th parent tocks possessed th characteristic normous crop The upposed boriginal tocks must all ha e been rock pigeons, that is, th y did not breed or willingl perch on trees. But besides *C l via*, with ts geographical sub-species, only two or three th speci s of rock p geons are kn wn and these ha n t any of th chara ters f the d mestic breeds. Hence the s pposed borig inal tocks must ther still exist in th coun tries wh re th w re originally d mesticated, and t be unkn wn to ornith logists and this, consid rin their size hab ts, and remarkable haract rs, seems improbable or th y must ha becom extinct in the wild tate. But birds breeding n precipices, and good fli rs, are unlik ly to be xt rminated and the com mon rock-pigeon, which has the sam habits with th domestic breeds, has not been xt minated n on several of the malle British islets, or on th shores of th Medit rranean. H nce the s pposed extermination of so many speci ha ing similar habits with the rock pigeon seems a ery rash assumption. More- th se ral abo named domesticated breeds ha been transported to all parts of th world, and, th refore som of th m must ha been carried back gain into th nati country but not one has become wild or f ral, though the d ecot-pigeon, which is th rock pigeon in a very slightly alt red tate has become f ral in se eral places. Again, all recent xperience show that t is difficult to g t wild animals to breed freel under domestication

doubtfully inclined to believe i n

t of the fowl alive having bred and crossed them and examined their skeletons it appears to me almost certain that all are the descendants of the wild Indian fowl *Gallus bankiva* and this is the con

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is of which differ much from each other the evidence is clear that they are all descended from the common wild duck and rabbit

The doctrine of the origin of our several domestic races from several aboriginal stocks has been carried to an absurd extreme by some authors They believe that every race which breeds true let the distinctive characters be ever so slight has had its wild prototype At

formerly existed eleven wild species of sheep peculiar to Great Britain! When we bear in mind that Britain has now not one peculiar mammal and France but few distinct from those of Germany and so with Hungary Spain &c but that each of these kingdoms possesses several peculiar breeds of cattle sheep &c we must admit that many domestic breeds must have originated in Europe for whence otherwise could they have been derived? So it is in India Even in the case of the breeds of the domestic dog throughout the world which I admit are descended from several wild species it cannot be doubted that there has been an immense amount of inherited variation for who will believe that animals closely resembling the Italian greyhound the bloodhound the bull dog pug dog or Blenheim spaniel &c —so unlike all wild Canidæ— ever existed in a state of nature? It has often been loosely said that all our races of dogs have been produced by the crossing of a few aboriginal species but by crossing we can only get forms in some degree intermediate between their parents and if we account for our several domestic races by this process we must admit the former existence of the most extreme forms as the Italian greyhound bloodhound bull dog &c in the wild state Moreover the possibility of making distinct races by crossing has been greatly exaggerated Many cases are on record showing that a race may be modified by occasional crosses if aided by the careful selection of the individuals which present the desired character but to obtain a race intermediate between two quite distinct races would be very difficult Sir J Sebright expressly experimented with this object and failed The offspring from the first cross between two pure breeds is tolerably and sometimes (as I have found with pigeons) quite uniform in character and everything seems simple enough but when these mongrels are crossed one with another for several generations hardly two of them are alike and then the difficulty of the task becomes manifest

Breeds of the Domestic Pigeon their Differences and Origin

Believing that it is always best to study some special group I have after deliberation taken up domestic pigeons I have kept every breed which I could purchase or obtain and have been most kindly favoured with skins from several quarters of the world more especially by the Hon W Elliot from India and by the Hon C Murray from Persia Many treatises in different languages have been published on pigeons and some of them are very important as being of considerable antiquity I have associated with several eminent fanciers and have been permitted to join two of the London Pigeon Clubs The diversity of the breeds is something astonishing Compare the English carrier and the short faced tumbler and see the wonderful difference in their beaks entailing corresponding differences in their skulls The carrier more especially the male bird is also remarkable from the wonderful development of the carunculated skin about the head and this is accompanied by greatly elongated eyelids very large external orifices to the nostrils and a wide gape of mouth The short faced tumbler has a beak

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size with long massive beak and large feet some of the sub breeds of runts have very long necks others very long wings and tails others singularly short tails The barb is allied to the carrier but instead of a long beak has a very short and broad one The pouter has a much elongated body wings and legs and its enormously developed crop which it glories in inflating may well excite astonishment and even laughter The turbit has a short and conical

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yet on the hypothesis of the multiple origin of our pigeons it must be assumed that at least seven or eight species were so thoroughly domesticated in ancient times by half-civilised man as to be quite prolific under confinement

An argument of great weight and applicable in several other cases is that the above specified breeds though agreeing generally with the wild rock pigeon in constitution habits voice colouring and in most parts of their structure yet are certainly highly abnormal in other parts we may look in vain through the whole great family of Columbidæ for a beak like that of the English carrier or that of the short faced tumbler or barb for reversed feathers like those of the Jacobin for a crop like that of the pouter for tail feathers like those of the fantail Hence it must be assumed not only that half-civilised man succeeded in thoroughly domesticating several species but that he intentionally or by chance picked out extraordinarily abnormal species and further that these very species have since all become extinct or unknown So many strange contingencies are improbable in the highest degree

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of d mesticat in E rope a d in India and that ta ree hal ts and in gr at numbe f po ts f tructu ith ll th dome ti breeds. Seco dly that, lth gh an Engl h carr r a h rt faced tumbl d ffe m nsely in c r tain charact s f m the ock p g n, y t that, by comparing tl se l b-b eds f th se t races, m re e pecially tl os b gl t fr m distant co ntries an m k bet n th m and th ock p geon, lmo t p rf ct n s so w can in some oth case l t t w th ll the b eeds. Tl dly those l aracters wh ch are mainly d tinct e f ach breed ar each minently ariabl f tance tl w ttl and length f beak f the carr tl hort ess of that of th tumbl and tl n mbe f ta l f th rs in the f tail nd tl plan ti n of this fact ll be b ou wl w t eat f Se lecti n. F urthly p geons l e be w tched and tended th th utm t ca d l ed by many people Th y ha been dom ticat d for th usands f y ar n se l q arters of th w ld th earl t kn n reco l of p geons is in the fifth Ægypti dy asty bo t 3000 B.C. as as po ted t t m by Professor Lepsius l t M ll h f rm m th t p geons ar giv n a b ll f f re the pr vious dynasty In th tim f th R s, as

Khan in India, abo t the y ar 1600 n less than 20 000 p geons wer taken w th th court. "The monar h of Iran and T ran sent him some ry rare b rds and contin the

courtly h sto ian "His M j sty by cro ing the breeds whi h m thod w s neve p ctised b fo e has imp ved th m astonish ngly About this sam p riod th Dutch were s eag r ab t p ge ns as we e the old Rom ns Tl paramount importan e f these c ns de atio n xpl i ng the imm nse am unt f variat n which p g ons have und rg ne will like i b ob s wh n we t eat of Selection We hall then l ee h w it is th t the s v e l bre ds o ft n ha m what mon str u charact It is also a mo t f vou ble circum ta ce fo the p oduction of di t n t breeds, that male and f m le p geons can be asily m ted fo l fe and thus d ff r nt b eeds can be k pt togeth r in th same a iary

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cated th y had ll p oceed d from a comm n par nt, as any natur list co ld in coming to a similar con lus n in g d to the many spec es of f hes r oth r g ps of b ds, in nature On circumstance has truck me much name ly that n arly ll the b ders f th various d m ti animal and th cultivato f plants w th wh m I ha conve sed, or whose t eat I have d are firmly c n n d that tl e sev l b eds to wh h each has ttended are d sce ded f m many ab gin lly distinct speci Ask, as I ha ask d a cel b ted ra s f He f d ttl wh the hi cattl m gl t n t ha d scen led f m l n h rns o both from a comm n pa nt tock d h w ll l gh y u to scorn I ha n t a p geon o po ltry r d ck, bb t f nci r who was n t fully convin d th t h m m b ed was descended f m a disti t pecies Van M ns, in hi tr tise n pears and apples h w h w utt ly he d bel that the se l rts f r instance Rib ton p pp n r Codlin pple could ha p oceed d f m th seed of th same tr e Inn m bl th xamples co ld b g n. Th explanati I think is mple f m l g-contin ed st dy th y ar

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Some authors believe that long-continued domestication eliminates this strong tendency to sterility in species From the history of the dog and of some other domestic animals, this conclusion is probably quite correct if applied to species closely related to each other But to

spring perfectly fertile *inter se* would be rash in the extreme

From these several reasons, namely,—the improbability of man having formerly made seven or eight supposed species of pigeons to breed freely under domestication,—these supposed species being quite unknown in a wild state, and their not having become anywhere feral,—these species presenting certain very abnormal characters, as compared with all other Columbidæ, though so like the rock-pigeon in most respects,—the occasional reappearance of the blue colour and various black marks in all the breeds, both when kept pure and when crossed,—and lastly, the mongrel offspring being perfectly fertile,—from these several reasons taken together, we may safely conclude that all our domestic breeds are descended from the rock-pigeon or Columba livia with its geographical sub-species.

In favour of this view, I may add, firstly, that the wild C. livia has been found capable of domestication in Europe and in India; and that it agrees in habits and in a great number of points of structure with all the domestic breeds. Secondly, that, although an English carrier or a short-faced tumbler differs immensely in certain characters from the rock-pigeon, yet that, by comparing the several sub-breeds of these two races, more especially those brought from distant countries, we can make, between them and the rock-pigeon, an almost perfect series; so we can in some other cases, but not with all the breeds. Thirdly, those characters which are mainly distinctive of each breed are in each eminently variable, for instance the wattle and length of beak of the carrier, the shortness of that of the tumbler, and the number of tail-feathers in the fantail; and the explanation of this fact will be obvious when we treat of Selection. Fourthly, pigeons have been watched and tended with the utmost care, and loved by many people. They have been domesticated for thousands of years in several quarters of the world; the earliest known record of pigeons is in the fifth Ægyptian dynasty, about 3000 B. C., as was pointed out to me by Professor Lepsius; but Mr. Birch informs me that pigeons are given in a bill of fare in the previous dynasty. In the time of the Romans, as we hear from Pliny, immense prices were given for pigeons; "nay, they are come to this pass, that they can reckon up their pedigree and race." Pigeons were much valued by Akber Khan in India, about the year 1600; never less than 20,000 pigeons were taken with the court. "The monarchs of Iran and Turan sent him some very rare birds;" and, continues the courtly historian, "His Majesty by crossing the breeds, which method was never practised before, has improved them astonishingly." About this same period the Dutch were as eager about pigeons as were the old Romans. The paramount importance of these considerations in explaining the immense amount of variation which pigeons have undergone, will likewise be obvious when we treat of Selection. We shall then, also, see how it is that the several breeds so often have a somewhat monstrous character. It is also a most favourable circumstance for the production of distinct breeds, that male and female pigeons can be easily mated for life; and thus different breeds can be kept together in the same aviary.

I have discussed the probable origin of domestic pigeons at some, yet quite insufficient, length; because when I first kept pigeons and watched the several kinds, well knowing how truly they breed, I felt fully as much difficulty in believing that since they had been domesticated they had all proceeded from a common parent, as any naturalist could in coming to a similar conclusion in regard to the many species of finches, or other groups of birds, in nature. One circumstance has struck me much; namely, that nearly all the breeders of the various domestic animals and the cultivators of plants, with whom I have conversed, or whose treatises I have read, are firmly convinced that the several breeds to which each has attended, are descended from so many aboriginally distinct species. Ask, as I have asked, a celebrated raiser of Hereford cattle, whether his cattle might not have descended from long-horns, or both from a common parent-stock, and he will laugh you to scorn. I have never met a pigeon, or poultry, or duck, or rabbit fancier, who was not fully convinced that each main breed was descended from a distinct species. Van Mons, in his treatise on pears and apples, shows how utterly he disbelieves that the several sorts, for instance a Ribston pippin or Codlin-apple, could ever have proceeded from the seeds of the same tree. Innumerable other examples could be given. The explanation, I think, is simple: from long-continued study they are strongly impressed with the differences between the several races; and though they well know that each race varies slightly, for they win their prizes by selecting such slight differences, yet they ignore all general arguments, and refuse to sum up in their minds slight differences accumulated during many successive generations. May not those naturalists who, knowing

far less of the laws of inheritance than does the breeder and knowing no more than he does of the intermediate links in the long lines of descent yet admit that many of our domestic races are descended from the same parents—may they not learn a lesson of caution when they deride the idea of species in a state of nature being lineal descendants of other species?

Principles of Selection anciently followed and their Effects

Let us now briefly consider the steps by which domestic races have been produced either from one or from several allied species Some effect may be attributed to the direct and definite action of the external conditions of life and some to habit but he would be a bold man who would account by such agencies for the differences between a dray and race horse a greyhound and bloodhound a carrier and tumbler pigeon One of the most remarkable features in our domesticated races is that we see in them adaptation not indeed to the animal s or plant s own good but to man s use or fancy Some variations useful to him have probably arisen suddenly or by one step many botanists for instance believe that the fuller s teasel with its hooks which cannot be rivalled by any mechanical contrivance is only a variety of the wild *Dipsacus* and this amount of change may have suddenly arisen in a seedling So it has probably been with the turnspit dog and this is known to have been the case with the ancon sheep But when we compare the dray horse and race horse the dromedary and camel the various breeds of sheep fitted either for cultivated land or mountain pasture with the wool of one breed good for one purpose and that of another breed for another purpose when we compare the many breeds of dogs each good for man in different ways when we compare the game cock so pertinacious in battle with other breeds so little quarrelsome with everlasting layers which never desire to sit and with the bantam so small and elegant when we compare the host of agricultural culinary orchard and flower garden races of plants most useful to man at different seasons and for different purposes or so beautiful in his eyes we must I think look further than to mere variability We cannot suppose that all the breeds were suddenly produced as perfect and as useful as we now see them indeed in many cases we know that this has not been their history The key is man s power of accumulative selection nature gives successive variations man adds them up in certain directions useful to him In this sense he may be said to have made for himself useful breeds

The great power of this principle of selection is not hypothetical It is certain that several of our eminent breeders have even within a single lifetime modified to a large extent their breeds of cattle and sheep In order fully to realise what they have done it is almost necessary to read several of the many treatises devoted to this subject and to inspect the

from highly competent authorities Youatt who was probably better acquainted with the works of agriculturists than almost any other individual and who was himself a very good judge of animals speaks of the principle of selection as that which enables the agriculturist not only to modify the character of his flock but to change it altogether It is the magician s wand by means of which he may summon into life whatever form and mould he pleases Lord Somerville speaking of what breeders have done for sheep says — It would seem as if they had chalked out upon a wall a form perfect in itself and then had given it existence In Saxony the importance of the principle of selection in regard to merino sheep is so fully recognised that men follow it as a trade the sheep are placed on a table and are studied like a picture by a connoisseur this is done three times at intervals of months and the sheep are each time marked and classed so that the very best may ultimately be selected for breeding

What English breeders have actually effected is proved by the enormous prices given for animals with a good pedigree and these have been exported to almost every quarter of the world The improvement is by no means generally due to crossing different breeds all the best breeders are strongly opposed to this practice except sometimes amongst closely allied sub breeds And when a cross has been made the closest selection is far more indispensable even than in ordinary cases If selection consisted merely in separating some very distinct variety and breeding from it the principle would be so obvious as hardly to be worth notice but its importance consists in the great effect produced by the accumulation in one direction during successive generations

of diff re ces bsolut ly in pp eciabl by an uned c ted e —d ff ce wh h I fo ne ha ai ly att mpted to pp ec ate Not one man n tl sa d has accu a y f ye and y d m t suffi t t becom an em e t breed If gifted w tl th se q lt s l st di his bject f y rs nd d t s l lf time t t th ind m t bl p rse e nce h ll cc ed, and m y mak g at mp o e m ts if he ants any f tl e q lt he w ll ass edly f L F w ld d h b l e e in th tural capacity and y f pract ce requ t t becom n k lf l p geon fanci

Th same p incipl are f ll ed by h t cult rsts b t the ariat ns e l e ften m re abrupt N ppose that h ce t

thus, t gi a ry t fling nstance th t adily creasing ze f th comm n goose berry m y be q ted W see an t m h ng impro m t in many fl t fl w wh n th fl w rs f th p ese t d y ar comp red w th dr ing m d ly tw nty thi ty y ar go. Wh n a ace f plants is ce pret ty ll tablished, th eed ai rs do n t p k t th be t plants, b t m rel g th ir seed beds, and p ll p th gu s, as

w t animals.

In regard to plants, ther is an th m ans f observing th accumulated ffects f selec ti —nam l b comparing th di rs t f fl ers in th diff rent ari ti f th sam pecie in th fl w gard n th di rs t f lea es, pods, t bers, what part is al ed, in th kit h gard n, in comparison with th flow rs f th sam ari ties and th di ersity of fruit f th sam species n th chard, in compariso with th l es and flo ers of th sam set of ari ties. See how differe t th lea es f th cabbag ar and h w trem l alik th fl w rs h w unlik th flowers f th heartsease are and h w alik the lea es how m ch th fru t f th diff rent kinds of gooseberries diff in size, col ur shape, and hairiness, and t th flow rs p se t ry light diff re ces It is n t that th arieties hich differ lar l in som point do not differ at all in the points this is hard

ly e e —I sp k aft r ca eful observati n —pe l p ne the cas The law f corr lated ar ti n, tl e importan e of which sh uld n r be o erlook d w ll n u e som d ff r n e b t, a gene al rul t cannot l do bted that th contin ed l ction of l gl t iat o s tl n tl l the fl w r or the fru t, w ll p od c ces differing from e h oth r hi fly in tl ese chara t rs

It m y be bj ted that the p inc ple f se lect on has be n reduced to method cal prac t c f r scarcely m re tl an th e-quart rs f a c ntury t h ce t nly been more tt nded t f l te year d m ny tr t se ha e be n p bl hed n the bject nd tl s lt l as be n m a co e j d g d g ee rapid and m portant. B t t ry f f m tru that the p inc pl is a mode n d co e v I c ld g e s l f e to w ks of high antiquit in which th f ll mportance f the p c ple is ackn wledged In rude nd barb rous pe riod f Engl h h t rv h ce an mal we oft n imp ted, d l w w e passed to pre t th xp rtat n the de truction f hors s u d r ce ta z was d red and this m y b comp red to th ogu ng f

passag n G es t is cl ar th t the col r f d m tic an mals was at that arly p od attended t S g w om t mes cross th ird g w th w ld ca ine an mals, to imp o th breed, and th f m ly did so, as is at tested by passage n Pliny The sav ge n So th Af ca m tch th draught cattl by col as d som f th Esquimaux th team of d g Li ng t e states that good d mesti b eed h ghly al ed by th n groes n th int ri f Africa wh ha n t associ ted w th Eu pean Som f th se f ct d n t h w t l lecti n, but th y h w that th b eeding f d m t c animals was car fully tt nded t in anci t t mes and n w tt ded t by th l w t sa g s It w ld indeed, h been a strang f ct, had tt nt on t been p d t breeding f th inh ritance f good and b d qu lities is so bvi us.

Uncons ous Selection

At th p esent tim min nt b eeders try by m thodical selecti n, w th di tin t bject in w to mak new train ub-b eed u peri to anythin of th kind in th country

far less of the laws of inheritance than does the bree ler and knowing no more than he does of the intermediate links in the long lines of de scent yet admit that many of our domestic races are descended from the same parents— may they not learn a lesson of caution when they deride the idea of species in a state of nature being lineal descendants of other species?

Principles of Selection anciently followed and their Effects

Let us now briefly consider the steps by which domestic races have been produced either from one or from several allied species Some effect may be attributed to the direct and definite action of the external conditions of life and some to habit but he would be a bold man who would account by such agencies for the differences between a dray and race horse a greyhound and bloodhound a carrier and tumbler pigeon One of the most remark able features in our domesticated races is that we see in them adaptation not indeed to the animal s or plant s own good but to man s use or fancy Some variations useful to him have probably arisen suddenly or by one step many botanists for instance believe that the fuller s teasel with its hooks which cannot be rivalled by any mechanical contrivance is only a variety of the wild *Dipsacus* and this amount of change may have suddenly arisen in a seedling So it has probably been with the turnspit dog and this is known to have been the case with the ancon sheep But when we compare the dray horse and race horse the dromedary and camel the various breeds of sheep fitted either for cultivated land or moun tain pasture with the wool of one breed good for one purpose and that of another breed for another purpose when we compare the many breeds of dogs each good for man in different ways when we compare the game cock so pertinacious in battle with other breeds so little quarrelsome with everlasting layers which never desire to sit and with the bantam so small and elegant when we compare the host of agricultural culinary orchard and flower garden races of plants most useful to man at different seasons and for different pur poses or so beautiful in his eyes we must I think look further than to mere variability We cannot suppose that all the breeds were suddenly produced as perfect and as useful as nature gives successive variations man adds them up in certain directions useful to him In this sense he may be said to have made for himself useful breeds

The great power of this principle of selection is not hypothetical It is certain that several of our eminent breeders have even within a single lifetime modified to a large extent their breeds of cattle and sheep In order fully to realise what they have done it is almost nec essary to read several of the many treatises devoted to this subject and to inspect the animals Breeders habitually speak of an ani mal s organisation as something plastic which they can model as they please If I had space I could quote numerous passages to this effect from highly competent authorities Youatt who was probably better acquainted with the works of agriculturists than almost any other individual and who was himself a very good judge of animals speaks of the principle of selection as that which enables the agricul turist not only to modify the character of his flock but to change it altogether It is the ma gician s wand by means of which he may sum mon into life whatever form and mould he pleases Lord Somerville speaking of what breeders have done for sheep says — It would seem as if they had chalked out upon a wall a form perfect in itself and then had given it existence In Saxony the importance of the principle of selection in regard to merino sheep is so fully recognised that men follow it as a trade the sheep are placed on a table and are studied like a picture by a connoisseur this is done three times at intervals of months and the sheep are each time marked and classed so that the very best may ultimately be se lected for breeding

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at the wonderf l skill of gardeners, in ha ing produced such splendid results from such poo materials b t th art has been simple, and, as far as th final s lt is concerned has been f llo ed almost unconsc ly It has con sisted in al y cultivating the be t known variet sowing ts seeds, and, wh n a l ghtly better vari ty chanced to ppear s ecting t, and so onwards. B t the garden rs f th class-ical period wh ulti ted th best pears hich they co ld p ocure, n r tho ght what sple did fruit w hould eat th ugh w o our xcellent fruit in som small d gree to their having naturally chosen and p eserved the best arieties th y could anywh find.

A larg amount f change, thus slowly and unconsciously accumulated explains, as I be-lie e, the well kn wn fact, that in a numbe of cases we cann t ecognise, and th refo d ot kn w th wild parent tocks f th pla ts which ha bee l gest cult ted in ou flow r and k tch n gard ns If t has tak n centuries th sand of y ars t impro modify most f plants p to th ir present standard f sef lness t man we can unde stand how t i that n th Au tralia, the Cape f Good H pe any oth r gi n in hab ted by quit unci lised man, has aff rded us singl plant w rth cult It is n t that these countries, so rich in species, d n t by a strange chance possess th aboriginal tocks of any useful plants, b t that th nat plants ha not been impro ed by co tinued selec-tion p to a tandard f perfecti n comparable th that acq red b th plant in countries anciently ci ilised

In regard to th d mesti animals k pt by unci ilised man, t h uld n t be o looked that th y almost alw ys ha to truggl for their own food t l ast during certain seasons. And in tw countries ry diff ntly circum tanced, ind d als f th sam spec es, ha ing slightly diff t constit ti ns tru t re would oft cceed bette th co try than in th th and thus by process of natural selecti n, as will h reaft be m re f lly xplained, tw sub-breeds m ght be f rm ed. This, pe haps, partly xplains why th arieties k pt by sa ges, as has been e-marked by som th rs, ha m re f th charact of tru species than th ari t es kept in ci ilised countri s.

On th w h re gi f th mportant part which selecti by man has played t be-comes t ce ob s, h w t is that ur do-mestic races show adaptation in thei tructure r in their hab ts to man s wants or fancies. W can, I think furth r understand th fre q ntly abn rmal characters of our d mestic races, and l k wise the r differences be g so gre t in e t rnal charact rs nd latively so l ght in i t rnal parts or or ans. Man can hardly select, o nly with n h difficulty any d t n of truct xcepting cl as is xternally sible and indeed he rarely cares for what is internal He can ne er act by selec-ti n excepti g n variatio s which ar first gi en to him som sl ght d gree by n ture No man w ld er try t make a fanta l till h saw a p geo w th a tail de l ped in some l l f gree in an unu u l mann r or pouter

m ma —

B t to use uch an expres n as try g to m k a fantail, is, I ha e no doubt, n most

p geon w ld become thro h long-continued partly unco sci s and partly m thodical, se-lecti n. Perhap the parent-bird f all fantails had only f urteen tail feathers somewhat ex panded, lik th present J va fantail, or lik indi duals of oth and dist ct breeds, in which as many as se enteen tail f athers ha e

ci rs, as t is n t n f the points f the breed

N l t t be tho ght that som great de ation f tru t re would be necessary to catch th fancier ey h perceives e tr m ly mall differences, and t is in h man nat t val e any n lty h w r slight, in own pos sessi n. N must th v l which wo ld for m y been set n any slight differences n th indi d ls f th same species, b j dged f by th alue which is n w set on them aft se ral breeds ha f irly been established. It is known that with p geons many l ght ariati ns n w occasi nally p-pear b t these are rejected as f ults d ti ns from th tandard f perfection in each breed. The comm n goose has n t gi en rise to any marked ari t es hence th T louse and th comm n breed which diffe only in colour that most fleeting of charact rs, have lately been exhib ted as distinct at ur poultry shows.

But for our purpose a form of Selection which may be called Unconscious and which results from every one trying to possess and breed from the best individual animals is more important Thus a man who intends keeping pointers naturally tries to get as good dogs as he can and afterwards breeds from his own best dogs but he has no wish or expectation of permanently altering the breed Nevertheless we may infer that this process continued during centuries would improve and *modify any breed in the same way as* Bakewell Collins &c by this very same process only carried on more methodically did greatly modify even during their lifetimes the forms and qualities of their cattle Slow and insensible changes of this kind can never be recognised unless actual measurements or careful drawings of the breeds in question have been made long ago which may serve for comparison In some cases however unchanged or but little changed individuals of the same breed exist in less civilised districts where the breed has been less improved There is reason to believe that King Charles s spaniel has been unconsciously modified to a large extent since the time of that monarch Some highly competent authorities are convinced that the setter is directly derived from the spaniel and has probably been slowly altered from it It is known that the English pointer has been greatly changed within the last century and in this case the change has it is believed been chiefly effected by crosses with the foxhound but *what concerns us is* that the change has been effected unconsciously and gradually and yet so effectually that though the old Spanish pointer certainly came from Spain Mr Borrow has not seen as I am informed by him any native dog in Spain like our pointer

By a similar process of selection and by careful training English race horses have come to surpass in fleetness and size the parent Arabs so that the latter by the regulations *for the Goodwood Races are favoured in the* weights which they carry Lord Spencer and others have shown how the cattle of England have increased in weight and in early maturity compared with the stock formerly kept in this country By comparing the accounts given in various old treatises of the former and present state of carrier and tumbler pigeons in Britain India and Persia we can trace the stages through which they have insensibly passed *and come to differ so greatly from the rock* pigeon

Youatt gives an excellent illustration of the effects of a course of selection *which may* be considered as unconscious in so far that the breeders could never have expected or even wished to produce the result which ensued—namely the production of two distinct strains The two flocks of Leicester sheep kept by Mr Buckley and Mr Burgess as Mr Youatt remarks have been purely bred from the original stock of Mr Bakewell for upwards of fifty years There is not a suspicion existing in the *mind of any one at all acquainted with the* subject that the owner of either of them has deviated in any one instance from the pure blood of Mr Bakewell s flock and yet the difference between the sheep possessed by these two gentlemen is so great that they have the appearance of being quite different varieties

If there exist savages so barbarous as never to think of the inherited character of the offspring of their domestic animals yet any one animal particularly useful to them for any special purpose would be carefully preserved *during famines and other accidents* to which savages are so liable and such choice animals would thus generally leave more offspring than the inferior ones so that in this case there would be a kind of unconscious selection going on We see the value set on animals even by the barbarians of Tierra del Fuego by their killing and devouring their old women in times of dearth as of less value than their dogs

*In plants the same gradual process of im*provement through the occasional preservation of the best individual whether or not sufficiently distinct to be ranked at their first appearance as distinct varieties and whether or not two or more species or races have become blended together by crossing may plainly be recognised in the increased size and beauty which we now see in the varieties of the heartsease rose pelargonium dahlia and *other plants* when compared with the older varieties or with their parent stock No one would ever expect to get a first rate heartsease or dahlia from the seed of a wild plant No one would expect to raise a first rate melting pear from the seed of the wild pear though he might succeed from a poor seedling growing *wild if it had come from a garden stock* The pear though cultivated in classical times appears from Pliny s description to have been a fruit of very inferior quality I have seen great surprise expressed in horticultural works

this animal has been surprisingly modified but improved by careful selection in peacocks, from not being very easily reared and large ... geese, from being valuable

singularly inflexible organisation, though it has varied to a slight extent, as I have elsewhere described.

Some authors have maintained that the amount of variation in our domestic productions is soon reached, and can never afterwards be exceeded. It would be somewhat rash to assert that the limit has been attained in any

instance there must be a limit to the fleetness of any terrestrial animal, as this will be determined by the friction to be overcome, the weight of body to be carried, and the power of contraction in the muscular fibres. But what concerns us is that the domestic varieties of the same species differ from each other in almost every character which man has attended to and selected more than do the distinct species of the same genera. Isidore Geoffroy St Hilaire has proved this in regard to size and so it is with colour and probably with the length of hair. With respect to fleetness, which depends on many bodily characters, Eclipse was far fleeter and a dray horse incomparably stronger than any two natural species belonging to the same genus. So with plants, the seeds of the different varieties of the bean or maize probably differ more in size, than do the seeds of the distinct species in any genus in the same two families. The same remark holds good in regard to the fruit of the ... the plum and still more

tions ...

causing variability both by acting directly on the organisation, and indirectly by affecting the reproductive system. It is not probable that variability is an inherent and necessary contingent, under all circumstances. The greater or less force of inheritance and reversion, determine whether variations shall endure. Va

we do not ...

definite action of the conditions of life. Some, perhaps a great, effect may be attributed to the increased use or disuse of parts. The final result is thus rendered infinitely complex. In

country the occasional intercrossing, with the aid of selection, has, no doubt, largely aided in the formation of new sub-breeds but the importance of crossing has been much exaggerated both in regard to animals and to those plants which are propagated by seed. With plants which are temporarily propagated by cuttings, buds, &c. the importance of crossing is immense for the cultivator may h

of little importance to us, for their endurance is only temporary. Over all these causes of Change, the accumulative action of Selection, whether applied methodically and quickly or unconsciously and slowly but more efficiently seems to have been the predominant P

These views appear to explain what has sometimes been noticed—namely that we know hardly anything about the origin or history of any of our domestic breeds But in fact a breed like a dialect of a language can hardly be said to have a distinct origin A man preserves and breeds from an individual with some slight deviation of structure or takes more care than usual in matching his best animals and thus improves them and the improved animals slowly spread in the immediate neighbourhood But they will as yet hardly have a distinct name and from being only slightly valued their history will have been disregarded When further improved by the same slow and gradual process they will spread more widely and will be recognised as something distinct and valuable and will then probably first receive a provincial name In semi civilised countries with little free communication the spreading of a new sub breed would be a slow process As soon as the points of value are once acknowledged the principle as I have called it of unconscious selection will always tend —perhaps more at one period than at another as the breed rises or falls in fashion —perhaps more in one district than in another according to the state of civilisation of the inhabitants —slowly to add to the characteristic features of the breed whatever they may be But the chance will be infinitely small of any record having been preserved of such *slow varying and insensible changes*

Circumstances favourable to Man s Power of Selection

*I will now say a few words on the circum*stance favourable or the reverse to man s power of selection A high degree of variability is obviously favourable as freely giving the materials for selection to work on not that mere individual differences are not amply sufficient with extreme care to allow of the accumulation of a large amount of modification in almost any desired direction But as variations manifestly useful or pleasing to man appear only occasionally the chance of their appearance will be much increased by a large number of individuals being kept Hence number is of the highest importance for success.

al ... y
proved On the other hand nurserymen from keeping large stocks of the same plant are generally far more successful than amateurs in raising new and valuable varieties A large number of individuals of an animal or plant can be reared only where the conditions for its propagation are favourable When the individuals are scanty all will be allowed to breed whatever their quality may be and this will effectually prevent selection But probably the most important element is that the animal or plant should be so highly valued by man that the closest attention is paid to even the slightest deviations in its qualities or structure Unless such attention be paid nothing can be effected I have seen it gravely remarked that it was most fortunate that the strawberry began to vary just when gardeners began to attend to this plant No doubt the strawberry had always varied since it was cultivated but the slightest varieties had been neglected As soon however as gardeners picked out individual plants with slightly larger earlier or

is an important element in the formation of new races —at least in a country which is al*ready stocked with other races In this respect* enclosure of the land plays a part Wandering *savages or the inhabitants of open plains rarely* possess more than one breed of the same species Pigeons can be mated for life and this is a great convenience to the fancier for thus *many races may be improved and kept true* though mingled in the same aviary and this circumstance must have largely favoured the formation of new breeds Pigeons I may add can be propagated in great numbers and at a very quick rate and inferior birds may be freely rejected as when killed they serve for food On the other hand cats from their nocturnal rambling habits cannot be easily matched and although so much value by women and children we rarely see a distinct breed long kept up such breeds as we do sometimes see are almost always imported from some other country *Although I do not doubt that some do*mestic animals vary less than others yet the *rarity or absence of distinct breeds of the cat* the donkey peacock goose &c may be attributed in main part to selection not having been brought into play in cats from the difficulty in pairing them in donkeys from only a

in many specimens f the sam pec es. It w ld ne r ha e been expected that th branching of the main n rves close to the great ~l l f an insect w uld ha e been

lace ject, pec ago con p c y u un termed t arieti s Fritz Müll l as l scr bed nalo o but m re traordinary cases

of a tem t tree. ... ist, I may add, has also sh n th t th muscles in the larvæ f certain nsects r far f m uniform. A thors sometim gu m a ci le he they tat that important rans ne ary for these sam th rs pra tically rank those parts as important (as som f w natural ists ha h estl confessed) lucl do n t arr and, d r this point f w in stance ill be f und f an mpo tant part arying b t und a y th po t f w many instances ass redl can be n

There is o point co ected w th ind d al diff rences, wh ch extremely perpl xi I ref to those g ra whi h h bee alled protean pol morph c, in wl ch the species prese t rdinat m unt f aria bo W th respect to many f these f rms, hardly two nat ralists gree wh tl e t rank them as species as ari t s. W may in tance R bus Rosa, and H ac m am gst plants, se ral g ra f insects and f l rach opod sh lls. In m st pol m rphic g ra som of tl pec h fixed ar d d finit cl arac t rs. G a wh h ar pol m rph country seem t be w th f w cepti ns, pol ym rphic in th co t es and lik wise, j dg g from brach pod sh lls, t f m periods of tim Th se facts are rs perpl xi f th y seem to sh th t tl kind of aria lity nd pend t f th condit ns f lif I m h ed to suspect that w see t least som of these polym rpl g ra, ariat ns wl ch are f no service d ssers ce t tl pec es, and hich conseq tl h n t bee seized and rend red d finit by natural selection, as h reaft t be xi la ed

Ind viduals of th sam species oft pre t, as k wn to ry e, gre t diff rences of truct re ndepend tly f ariation, as in the t se f ario animals, n th tw or three castes f t rile f mal o wo k rs amo gst nsects, d tl mm ture and lar val t t f man f tl low an mals. Th re are also, ases of d m rj h sm and trim rphism, both w th animals and plants. Thus, M Wal-

f th se ases, th two r three f rms, both w th animals and plants are n t now co nected by int rmed t grad t ons, t is prob ble that th y were o ce tl u connected Mr Wallace f r instance, d sc be a certain butt rfly which presents in th same land gre t range f a n ti con ected b t rmed te l nks, and th trem links f tl chain losely resembl th two f rm of an all ed d m rph c pecies n hab ting an tl part f the Mal y Arcl pel ag Th lso w th ts, th se ral w k caste are g n rally ju t distin t b t som cases, as w h ll l reaft ce tl ca t are connected t g tl by fi l grad ted rie t s. So t is, as I myself bserved w tl so e d m rphi plants. It ce tainly at fi t j pears highly rema kabl fact th t th sam f mal butt rfly h uld ha th pow f prod ing at the sam tim three dist n t femal f rms and a mal and th t an h rm phrod t plant sh ld produce from th sam seed-c p ule thre dist n t h rmaphrodite f ms, be g

n f t that th f m l produce off pring of tw se es h l som tim diffe from ach tl in nd rful mann

D btful Species

Th f n wl h posse som cons d abl d gree tl ha acte of pecies b t wl ch are so l sel m lar to th f ms, are so losely linked t th m by t rmed t gr d ti ns, that nat alists d n t lik t rank th m as d ti t pec s, are n se eral respects th most important f us. W ha ry reason t beli that many f these d btful ar d closely all ed f rms h pe man ently retained th ir chara ters f a l g tim f as l as far as w kn w as ha good and true pec es. Practicall wh a naturalist can unite by m ans f int rmedi te links any two forms, h

CHAPTER II

VARIATION UNDER NATURE

BEFORE applying the principles arrived at in the last chapter to organic beings in a state of nature we must briefly discuss whether these latter are subject to any variation To treat this subject properly a long catalogue of dry facts ought to be given but these I shall reserve for a future work Nor shall I here discuss the various definitions which have been given of the term species No one definition has satisfied all naturalists yet every naturalist knows vaguely what he means when he speaks of a species Generally the term in

of descent is almost universally implied though it can rarely be proved We have also what are called monstrosities but they graduate into varieties By a monstrosity I presume is meant some considerable deviation of structure generally injurious or not useful to the species Some authors use the term variation in a technical sense as implying a modification directly due to the physical conditions of life and variations in this sense are supposed not to be inherited but who can say that the

far northly ... would not in some cases be inherited for at least a few generations? And in this case I presume that the form would be called a variety

It may be doubted whether sudden and considerable deviations of structure such as we occasionally see in our domestic productions

fully related to its complex conditions of life that it seems as improbable that any part should have been suddenly produced perfect as that a complex machine should have been invented by man in a perfect state Under domestication monstrosities sometimes occur which resemble normal structures in widely different animals Thus pigs have occasionally been born with a sort of proboscis and if any wild species of the same genus had naturally possessed a proboscis it might have been argued that this had appeared as a monstrosity but I have as yet failed to find after diligent search cases of monstrosities resembling normal structures in nearly allied forms and these alone bear on the question If monstrous forms of this kind ever do appear in a state of nature and are capable of reproduction (which is not always the case) as they occur rarely and singularly their preservation would depend on unusually favourable circumstances They would also during the first and succeeding generations cross with the ordinary form and thus their abnormal character would almost inevitably be lost But I shall have to return in a future chapter to the preservation and perpetuation of single or occasional variations

Individual Differences

The many slight differences which appear in the offspring from the same parents or which it may be presumed have thus arisen from being observed in the individuals of the same species inhabiting the same confined locality may be called individual differences No one *supposes that all the individuals of the same*

afford material for natural selection to act on and accumulate in the same manner as man accumulates in any given direction individual

that parts which must be called important whether viewed under a physiological or classificatory point of view sometimes vary in the individuals of the same species I am convinced that the most experienced naturalist would be surprised at the number of the cases of variability even in important parts of structure *which he could collect on good authority* as I have collected during a course of years It should be remembered that systematists are far from being pleased at finding variability in important characters, and that there are not *many men* who will laboriously examine internal and important organs and compare them

them as d t ct peci b t wh t d tance t has bee ll as ed, ll ffice f th t be t ee Am ne and E rop t ampl w ll th t bet ee E rope and th Az s, Mad ra, or th Canar es, between th se e l sl ts f these mall archipela s, b ffic e t

M B D Walsh, d tinguished ntom lo- gist of the Un ted Stat s, l descr bed what h call phytopl g n t d phyto- phag spec M t v g tabl feeding insects h k d f plant n ne gro p f plant som feed discrim t l ma y kinds, b t d t a conseq n ary In ral ases, h nsects f und h g n d ff re t plants, h e been b ed by Mr Walsh t prese t in tl lar al m t re state, in both t tes, light tl l nstant d ff rences col si e, n th n t re f the secret ns. In som in tance th m le fo in th tance b th mal d fe- mal s, l bee bserved th to d ff n a light d g ee Wh tl d ff re ce re r th m tro gl m ked nd wh b th se l ll re ffected, th f m anked

mere usel ss al t act n mpl ing and assum ng p t act f r at n It certain that many f ms, cons de ed by h ghly-compet t j dg t b ariet e embl pecies so com plet ly n l ract th t they ha e been thus r nked by tl b ghly-compete t judg s But t discuss h th th v ught to be called spe r ari t s, b fore any d finit n of th e te ms has been g n rally acc pted inly to b t th air

Many of tl e ases f t gly marked va i t s d btf l pec es w ll deserve cons de a t f r se r l t re t ng lines f arg m nt, from geog phic l d st but analog cal a l f l m &c l been bro gl t to

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n d ubt br g t al ts to ag ee l n to ank d btful f ms. Y t t mu t b co f ssed th t t the b t k wn count e th t e find th gre t t n mb f th m I ha e been tru k with th fact, th t f any an m l o plant tat f nat re b h ghly u f l to man r from any l sely tt a t l s t t l ar t s f t w ll lm st un ersally l f d ecorded Th var t m reo

cross, as t an l th wl h ppe t ha lost th po as pec l th d ff nce d pe d th in ect l g l ng fed n d t t pla ts, t can t l xpected tl t in termed t l ks co ectin th se l f ms sh ld l f d Tl t l t tl l se has be t gu d d t m g wl tl to rank d btf l f as n t pec Tl lik se e ssa l occ tl l sel alled gams s, l h l b t d t t tin ts la l Wl tl th h d an m l pla t g tl sam co t t h t t m lar d in tl sam rel pel go, al prese ts d ff re t f m th d ff t ar a th al good l ance th t unt m t t f rm ll be d sco red wh h ll link t tl tl trem tates d th ar tl d g aded t tl ank f n t s.

S m f w t al ts m tai tl t an mal prese t n t b t th these m nat lists k tl l ght t d ff re ce f per f l d wh th sam d t cal t t tl t d tant co tri s, in t g ol ical f mat ns, th y b l th t t d t t pec l ld d th sam dress. Th t m pec thus com to be a

m re than d n pec t of f ms, wl ch a lm t u sally co d red by oth b t ts t b t and n this co try tl e

pec m re t

I m y l ll d t a remarkabl m m l t l p bl led b A d Cand ll n th oaks f th wh l ld N r had more mpl n t ls f tl d scrimin t n f tl pec s, co ld h ked n th m th

th rel t f i f th n ti He pec fi bo d ch act rs whi h m y b f d rs n th sam b h som t ccord g t g d l pm t som t m tl t any ass nabl reason S ch l act rs re t f co se f pecific al b t th y as Asa G y has remarked n com t th m ir ch as g ally nt t pec fi d fi t ns. D Ca d ll th n goe n t say th t h g es th ank f pec es to th f rms that diff r by charact

treats the one as a variety of the other, ranking the most common, but sometimes the one first described, as the species, and the other as the variety. But cases of great difficulty, which I will not here enumerate, sometimes arise in deciding whether or not to rank one form as a variety of another, even when they are closely connected by intermediate links; nor will the commonly assumed hybrid nature of the intermediate forms always remove the difficulty. In very many cases, however, one form is ranked as a variety of another, not because the intermediate links have actually been found, but because analogy leads the observer to suppose either that they do now somewhere exist, or may formerly have existed; and here a wide door for the entry of doubt and conjecture is opened.

Hence, in determining whether a form should

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jority of naturalists, for few well-marked and well-known varieties can be named which have not been ranked as species by at least some competent judges.

That varieties of this doubtful nature are far from uncommon cannot be disputed. Compare the several floras of Great Britain, of France, or of the United States, drawn up by different botanists, and see what a surprising number of forms have been ranked by one botanist as good species, and by another as mere varieties. Mr. H. C. Watson, to whom I lie under deep obligation for assistance of all kinds, has marked for me 182 British plants, which are generally considered as varieties, but which have all been ranked by botanists as species; and in making this list he has omitted many trifling varieties, but which nevertheless have been ranked by some botanists as species, and he has entirely omitted several highly polymorphic genera. Under genera, including the most polymorphic forms, Mr. Babington gives 251 species, whereas Mr. Bentham gives only 112,—a difference of 139 doubtful forms! Amongst animals which unite for each birth, and which are highly locomotive, doubtful forms, ranked by one zoologist as a species and by another as a variety, can rarely be found within the same country, but are common in separated areas. How many of the birds and insects in North America and Europe, which differ very slightly from each other, have been ranked by one eminent naturalist as undoubted species, and by another as varieties, or, as they are often called, geographical races! Mr. Wallace, in several valuable papers on the various animals, especially on the Lepidoptera, inhabiting the islands of the great Malayan archipelago, shows that they may be classed under four heads, namely, as variable forms, as local forms, as geographical races or sub-species, and as true representative species. The first or variable forms vary much within the limits of the same island. The local forms are moderately constant and distinct in each separate island; but when all from the several islands are compared together, the differences are seen to be so slight and graduated, that it is impossible to define or describe them, though at the same time the extreme forms are sufficiently distinct. The geographical races or sub-species are local forms completely fixed and isolated; but as they do not differ from each other by strongly marked and important characters,

there is no possible test but individual opinion to determine which of them shall be considered as species and which as varieties. Lastly, representative species fill the same place in the natural economy of each island as do the local forms and sub-species; but as they are distinguished from each other by a greater amount of difference than that between the local forms and sub-species, they are almost universally ranked by naturalists as true species. Nevertheless, no certain criterion can possibly be given by which variable forms, local forms, sub-species, and representative species can be recognised.

Many years ago, when comparing, and seeing others compare, the birds from the closely neighbouring islands of the Galapagos Archipelago, one with another, and with those from the American mainland, I was much struck how entirely vague and arbitrary is the distinction between species and varieties. On the islets of the little Madeira group there are many insects which are characterized as varieties in Mr. Wollaston's admirable work, but which would certainly be ranked as distinct species by many entomologists. Even Ireland has a few animals, now generally regarded as varieties, but which have been ranked as species

species, whereas the greater number rank it as an undoubted species peculiar to Great Britain. A wide distance between the homes of two doubtful forms leads many naturalists to rank

known to be the case by Mr Wollaston with the varieties of certain fossil land-shells in Madeira, and with plants by Gaston de Saporta. If a variety were to flourish so as to exceed in numbers the parent species, it would then rank as the species, and the species as the variety; or it might come to supplant and exterminate the parent species; or both might co-exist, and both rank as independent species. But we shall hereafter return to this subject.

From these remarks it will be seen that I look at the term species as one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other, and that it does not essentially differ from the term variety, which is given to less distinct and more fluctuating forms. The term variety, again, in comparison with mere individual differences, is also applied arbitrarily, for convenience sake.

Wide-ranging, much diffused, and common Species vary most

Guided by theoretical considerations, I thought that some interesting results might be obtained in regard to the nature and relations of the species which vary most, by tabulating all the varieties in several well-worked floras. At first this seemed a simple task; but Mr H. C. Watson, to whom I am much indebted for valuable advice and assistance on this subject, soon convinced me that there were many difficulties, as did subsequently Dr Hooker, even in stronger terms. I shall reserve for a future work the discussion of these difficulties, and the tables of the proportional numbers of the varying species. Dr Hooker permits me to add that after having carefully read my manuscript, and examined the tables, he thinks that the following statements are fairly well established. The whole subject, however, treated as it necessarily here is with much brevity, is rather perplexing, and allusions cannot be avoided to the "struggle for existence," "divergence of character," and other questions, hereafter to be discussed.

Alphonse de Candolle and others have shown that plants which have very wide ranges generally present varieties; and this might have been expected, as they are exposed to diverse physical conditions, and as they come into competition (which, as we shall hereafter see, is an equally or more important circumstance) with different sets of organic beings. But my tables further show that, in any limited country, the species which are the most common, that is abound most in individuals, and the species which are most widely diffused within their own country (and this is a different consideration from wide range, and to a certain extent from commonness), oftenest give rise to varieties sufficiently well marked to have been recorded in botanical works. Hence it is the most flourishing, or, as they may be called, the dominant species,—those which range widely, are the most diffused in their own country, and are the most numerous in individuals,—which oftenest produce well-marked varieties, or, as I consider them, incipient species. And this, perhaps, might have been anticipated; for as varieties, in order to become in any degree permanent, necessarily have to struggle with the other inhabitants of the country, the species which are already dominant will be the most likely to yield offspring, which, though in some slight degree modified, still inherit those advantages that enabled their parents to become dominant over their compatriots. In these remarks on predominance, it should be understood that reference is made only to the forms which come into competition with each other, and more especially to the members of the same genus or class having nearly similar habits of life. With respect to the number of individuals or commonness of species, the comparison of course relates only to the members of the same group. One of the higher plants may be said to be dominant if it be more numerous in individuals and more widely diffused than the other plants of the same country, which live under nearly the same conditions. A plant of this kind is not the less dominant because some conferva inhabiting the water or some parasitic fungus is infinitely more numerous in individuals and more widely diffused. But if the conferva or parasitic fungus exceeds its allies in the above respects, it will then be dominant within its own class.

Species of the Larger Genera in each Country vary more frequently than the Species of the Smaller Genera

If the plants inhabiting a country as described in any Flora, be divided into two equal masses, all those in the larger genera (i.e., those including many species) being placed on one side, and all those in the smaller genera on the other side, the former will be found to include a somewhat larger number of the very common and much diffused or dominant species. This might have been anticipated; for the

never varying on the same tree and never found connected by intermediate states After this discussion the result of so much labour he emphatically remarks They are mistaken *who repeat that the greater part of our species* are clearly limited and that the doubtful species are in a feeble minority This seemed to be true so long as a genus was imperfectly known and its species were founded upon a few specimens that is to say were provisional Just as we come to know them better intermediate forms flow in and doubts as to specific limits augment. He also adds *that it is the best* known species which present the greater number of spontaneous varieties and sub varieties Thus *Quercus robur* has twenty eight varieties all of which excepting six are clustered round *three sub species namely Q pedunculata sessiliflora* and *pubescens* The forms which connect these three sub species are comparatively rare and as Asa Gray again remarks if these connecting forms which are now rare were to become wholly extinct the three sub species would hold exactly the same relation to each other as do the four or five provisionally admitted *species which closely surround the typical Quercus robur* Finally De Candolle admits that out of the 300 species which will be enumerated in his *Prodromus* as belonging to the oak family at least two-thirds are provisional species that is are not known strictly to fulfil the definition above given of a true species It should be added that De Candolle no longer believes that *species are immutable creations* but concludes that the derivative theory is the most natural one and the most accordant with the known facts in palæontology geographical botany and zoology of anatomical structure and classification

When a young naturalist commences the study of a group of organisms quite unknown *to him he is at first much perplexed in determining* what differences to consider as specific and what as varietal for he knows nothing of the amount and kind of variation to which the group is subject and this shows at least how very generally there is some variation But if he confine his attention to one class within one country he will soon make up his mind how to rank *most of the doubtful forms* His general tendency will be to make many species for he will become impressed just like the pigeon or poultry

amount

continu...

knowledge of analogical variation in other groups and in other countries by which to correct his first impressions As he extends the range of his observations, he will meet with more cases of difficulty for he will encounter a greater number of closely allied forms But if his observations be widely extended he will in the end generally be able to make up his own mind but he will succeed in this at the expense of admitting much variation —and the truth of this admission *will often be disputed by* other naturalists When he comes to study allied forms brought from countries not now continuous in which case he cannot hope to find intermediate links he will be compelled to trust almost entirely to analogy and his difficulties will rise to a climax

Certainly no clear line of demarcation has as *yet been drawn between species and sub* species—that is the forms which in the opinion of some naturalists come very near to but do not quite arrive at the rank of species or again between sub species and well marked varieties or between lesser varieties and individual differences These differences blend into each other by an insensible series and a *series impresses the mind with the idea of an* actual passage

Hence I look at individual differences, though of small interest to the systematist as of the highest importance for us as being the first steps towards such slight varieties as are barely thought worth recording in works on natural history And I look at varieties which are in any *degree more distinct and permanent* as steps towards more strongly marked and permanent varieties and at the latter as leading to sub species and then to species The passage from one stage of difference to another may in many cases be the simple result of the nature of the organism and of the different physical conditions to which it has long been exposed but with respect to the more important and adaptive characters the passage from one stage of difference to another may be *safely attributed to the cumulative action of* natural selection hereafter to be explained and to the effects of the increased use or disuse of parts A well marked variety may therefore be called an incipient species but whether this belief is justifiable must be judged by the weight of the various facts and considerations to be given throughout this work

It need not be supposed that all varieties or incipient species attain the rank of species They may become extinct or they may endure *as varieties for very long periods, as has been*

a species is often exceed.n.ly small. I hav n-deavoured to test this numerically b a ra es, and, as far as m imperfect results go, they confirm the view I ha e also consulted som sagacious and experienced observ rs, and after deliberation, t v concur in this w In this respect, therefore, th species of the larger genera resemble varieties, more than d th species of the smaller genera. O th case may be put in another w and t may be said, that in the larger genera, in which a number of varieties or incipient pecies gre t than th average are now manufacturing, many of the species alread manufactured still t certain extent resemble varieties, f th v diff r from each other by less than the usual am unt of difference.

Moreover th species of th larger g nera are related to each other in th sam mann as the varieties of an on species are related to each other \ naturalist pret nds that all the species of a genus are equall distinct from each other the ma generall be divided into sub-genera, or sections lesser groups. As F es has w ll remarked, litt groups of species are general clustered lik sat llites around other species. And what are var ties b t groups of forms, unequall related to each other and clust red round certain forms—that is, round their parent species. Und ubt edly there is one most important point of dif ference between varieties and pecies namely that the amount of diff rence between arieties, hen compared w th each other or with their parent species, is much less than that be t een the species of th same g nus. B t when com to discuss th principle, as I call t, of D ergence of Character w shall see how this ma be explained, and how th lesse diff ences between varieties t nd t increase into the greater differences between species.

There is one oth point which is worth notice. Varieties general ha e much restricted ranges this stat ment is indeed scarcel more than truism, for if ariet were found to ha wider rang than that of ts supposed parent species, their d nominations would be reversed. B t there is reason to beli that the species which are ry closel allied to other species, and in so far resemble arieties, often ha much restricted ranges. For instance, Mr H. C Watson has marked f m in the w ll-sifted *London Catalogue f Plants* (4th ed tion) 63 plants which are therein ranked as species, but which h considers as so closely allied to other species as to be of d ubtful al e these 63 reputed species range n an rag o 6.9 of the pro inces into which Mr Watson has divided Great Britain. \ w in this same *C t logue* 3 acknowled ed vari ties are recorded and these range over pro inces wh reas, th spec es to which tl ese vari ties belong range o 14.3 provinces. So that the acknowledged ri t es hav n arl the same restri ted rage range as ha e th closely allied f rms, marked f r m by M W tson as doubtf l pecies, but which are al most uni rsally ranked by British botanists as good and tru pecies.

Summary

Finall vari ties cannot be distinguished from species,—except, first, by th disco ry of intermediat linking f rm and, secondl b a certain ind finit amount of diff rence between th m for two forms, if differing v ry little are gen rally ranked as varieties, n t withstanding that th y cannot be closely connected b t th amount of diff rence consid red necessary to gi e to an two f rms th rank of pec es cannot be defined. In gen ra having more than the era number of pecies in an country th species of these g n ra h e more than th vera numbe of arie t es. In large gen ra the species are apt to be

restricted ranges. In all these respects th species of large g n ra present trong analogy with ari ties. And w can learly understand these analogies, if species nce exi ted as arieties, and thus originated whereas, these analogies are utt rly inexplicable if species are ind pendent creations.

W have also, seen that t is th most flourishin o dominant species of the large g nera within ach class which on an verage yield th greatest umbe of vari ties and ar ties, as w shall hereafte see t nd to become con rted into new and distinct species. Thus th large genera tend to become large and throughout nature th forms of lif which are now dominant tend to becom still more d minant b le ing man modified and d minant descendants. B t b t ps h reaft to be ex plained, the large genera also t nd to break p into smaller ge era. And thus, th f rms of lif througho t the uni erse becom divided into groups subordinate to groups.

mere fact of many species of the same genus inhabiting any country shows that there is something in the organic or inorganic conditions of that country favourable to the genus and consequently we might have expected to have found in the larger genera or those including many species a larger proportional number of dominant species But so many causes tend to obscure this result that I am surprised that my tables show even a small majority on the side of the larger genera I will here allude to only two causes of obscurity Fresh water and salt loving plants generally have very wide ranges and are much diffused but this seems to be connected with the nature of the stations inhabited by them and has little or no relation to the size of the genera to which the species belong Again plants low in the scale of organisation are generally much more widely diffused than plants higher in the scale and here again there is no close relation to the size of the genera. The cause of lowly organised plants ranging widely will be discussed in our chapter on Geographical Distribution

From looking at species as only strongly marked and well-defined varieties I was led to anticipate that the species of the larger genera in each country would oftener present varieties than the species of the smaller genera for wherever many closely related species (i e

large trees grow we expect to find saplings Where many species of a genus have been formed through variation circumstances have been favourable for variation and hence we might expect that the circumstances would generally be still favourable to variation On the other hand if we look at each species as a special act of creation there is no apparent reason why more varieties should occur in a group having many species than in one having few

To test the truth of this anticipation I have arranged the plants of twelve countries and the coleopterous insects of two districts into two nearly equal masses the species of the larger genera on one side and those of the smaller genera on the other side and it has invariably proved to be the case that a larger proportion of the species on the side of the larger genera presented varieties than on the side of the smaller genera. Moreover the species of the large genera which present any varieties invariably present a larger average number of varieties than do the species of the small genera Both these results follow when another division is made and when all the least genera, with from only one to four species are altogether excluded from the tables These facts are of plain signification on the view that species are only strongly marked and permanent varieties for wherever many species of the same genus have been formed or where if we may use the expression the manufactory of species has been active we ought generally to find the manufactory still in action more especially as we have every reason to believe the process of manufacturing new species to be a slow one And this certainly holds true if varieties be looked at as incipient species for my tables clearly show as a general rule that wherever many species of a genus have been formed the species of that genus present a number of varieties that is of incipient species beyond the average It is not that all large genera are now varying much and are thus increasing in the number of their species or that no small genera are now varying and increasing for if this had been so it would have been fatal to my theory inasmuch as geology plainly tells us that small genera have in the lapse of time often increased greatly in size and that large genera have often come to their maxima, declined and disappeared All that we want to show is that when many species of a genus have been formed on an average many are still forming and this certainly holds good

Many of the Species included within the Larger Genera resemble Varieties in being very closely but unequally related to each other and in having restricted ranges

is no infallible criterion by which to distinguish species and well marked varieties and when intermediate links have not been found between doubtful forms naturalists are compelled to come to a determination by the amount of difference between them judging by analogy whether or not the amount suffices to raise one or both to the rank of species. Hence the amount of difference is one very important criterion in settling whether two forms should be ranked as species or varieties Now Fries has remarked in regard to plants and Westwood in regard to insects that in large genera the amount of difference between the

The Term Struggle for Existence used in a large sense

I h ld prem tl t I th s term n a large and metaph rical s e i cludi g de pe d nce f e b g an tl nd ncl d m (wh ch m re mportant) u t o ly tl l fe f th d vidual l t cee l g pro- f T mal n a t m f d arth

l l h l l dy cl tl tl g d the

many u se p as t l g les and d B t se l se dl g m tl toe grow g cl t g the n tl am l

each th I u f co k tn g al term f Struggl f E ist ce

Ge metrical Ratio f Incre se

n tural lif t me prod l b d m t ff r d t t d g p od f ts lif and d g som seaso occas l th ew tl nn l f geom t al

m t rv ase be truggl f xi t tl d d l tl tl f tl pec tl tl ind d l f d t t l w th tl pl y l o d t is f l fe. It tl doctri f Malth ppl ed w th f ld f rce to th wl le animal and v g t bl k gd m f in tl is case tl re can b n art f cial rease I food and o prud nt al restrai t rom marr age. Alth gh som pe

ce m y be now inc easing m re r less rap d ly n numbers all can ot do so f r tl e w rld w ld not hold them

Th i no e c pt n to the rul tl at every ga c b g natu ally i c eases t so h gl a rat that f n t d tr yed th arth wo ld so n b o c l by th prog y f a s ngle pai E en low bi edi g man has do bled n t nty fi ea a d at tl rate in less tl n a tl u a d yea tl e e wo ld l t rally not be tai l g m f r l s p geny Li nœu has cal ulated th t f an an al pl nt prod ced only two seed —and tl re i n plant so un prod ct ve as th s— l tl e r eedlings next ye r prod ced tw d tl n m tw ty m ll n plants Tl

n ly n teen n ll n l ph nt i ve u

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ar no tl co m est o tl wh l plai f La l l ta, l tl g l gi f rface lm t t tl l n f y ther plant l b trod d f m E l d th e re plai ts wh l n w ang n Ind a, as I l f D F lco r f m C pe Com n to the H m l ya, wl ch h been impo ted f om Am its d sco y In cl as and dl ss tl co ld be g en ppose th t th f tl ty f th an mal plants has b dd ly and tempo rily increased n

CHAPTER III

STRUGGLE FOR EXISTENCE

BEFORE entering on the subject of this chapter I must make a few preliminary remarks to show how the struggle for existence bears on Natural Selection It has been seen in the last chapter that amongst organic beings in a state of nature there is some individual variability indeed I am not aware that this has ever been disputed It is immaterial for us whether a multitude of doubtful forms be called species or sub species or varieties what rank for instance the two or three hundred doubtful forms of British plants are entitled to hold if the existence of any well marked varieties be admitted But the mere existence of individual variability and of some few well marked varieties though necessary as the foundation for the work, helps us but little in understanding how species arise in nature How have all those exquisite adaptations of one part of the organisation to another part and to the conditions of life and of one organic being to another being been perfected? We see these beautiful co adaptations most plainly in the woodpecker and the mistletoe and only a little less plainly in the humblest parasite which clings to the hairs of a quadruped or feathers of a bird in the structure of the beetle which dives through the water in the plumed seed which is wafted by the gentlest breeze in short we see beautiful adaptations everywhere and in every part of the organic world

Again it may be asked how is it that varieties which I have called incipient species become ultimately converted into good and distinct species which in most cases obviously differ from each other far more than do the varieties of the same species? How do those groups of species which constitute what are called distinct genera and which differ from each other more than do the species of the

gle variations however slight and from whatever cause proceeding if they be in any degree profitable to the individuals of a species in their infinitely complex relations to other organic beings and to their physical conditions of life will tend to the preservation of such individuals and will generally be inherited by the offspring The offspring also will thus have a better chance of surviving for of the many individuals of any species which are periodically born but a small number can survive I have called this principle by which each slight variation if useful is preserved by the term Natural Selection in order to mark its relation to man s power of selection But the expression often used by Mr Herbert Spencer of the Survival of the Fittest is more accurate and is sometimes equally convenient. We have seen that man by selection can certainly produce great results and can adapt organic beings to his own use through the accumulation of slight but useful variations given to him by the hand of Nature But Natural Selection as we shall hereafter see is a power incessantly ready for action and is as immeasurably superior to man s feeble efforts as the works of Nature are to those of Art.

We will now discuss in a little more detail the struggle for existence In my future work this subject will be treated as it well deserves at greater length The elder De Candolle and Lyell have largely and philosophically shown that all organic beings are exposed to severe competition In regard to plants no one has treated this subject with more spirit and ability than W Herbert Dean of Manchester evidently the result of his great horticultural knowledge Nothing is easier than to admit in words the truth of the universal struggle for life or more difficult—at least I have found it so—than constantly to bear this conclusion in mind Yet unless it be thoroughly engrained in the mind the whole economy of nature with every fact on distribution rarity abundance extinction and variation will be dimly seen or quite misunderstood We behold the face of nature bright with gladness we often see superabundance of food we do not see or we forget that the birds which are idly singing round us mostly live on insects or seeds and are thus constantly destroying life or we forget how largely these songsters or their eggs or their nestlings are destroyed by birds and beasts of prey we do not always bear in mind that, though food may be now superabundant it is not so at all seasons of each recurring year

f... grown plants: thus out of twenty species growing on a little plot of mown turf (three feet by four) nine species perished, from the other species being allowed to grow up freely.

The amount of food for each species of course gives the extreme limit to which each can increase; but very frequently it is not the obtaining food, but the serving as prey to other animals, which determines the average numbers of a species. Thus, there seems to be little doubt that the stock of partridges, grouse, and hares on any large estate depends chiefly on the destruction of vermin. If not one head of game were shot during the next twenty years in England, and, at the same time, if no vermin were destroyed, there would, in all probability, be less game than at present, although hundreds of thousands of game animals are now annually shot. On the other hand, in some cases, as with the elephant, none are destroyed by beasts of prey: for even the tiger in India most rarely dares to attack a young elephant protected by its dam.

Climate plays an important part in determining the average number of a species, and periodical seasons of extreme cold or drought seem to be the most effective of all checks. I estimated (chiefly from the greatly reduced numbers of nests in the spring) that the winter of 1854–5 destroyed four-fifths of the birds in my own grounds; and this is a tremendous destruction, when we remember that ten per cent. is an extraordinarily severe mortality from epidemics with man. The action of climate seems at first sight to be quite independent of the struggle for existence; but in so far as climate chiefly acts in reducing food, it brings on the most severe struggle between the individuals, whether of the same or of distinct species, which subsist on the same kind of food. Even when climate, for instance extreme cold, acts directly, it will be the least vigorous individuals, or those which have got least food through the advancing winter, which will suffer most. When we travel from south to north, or from a damp region to a dry, we invariably see some species gradually getting rarer and rarer, and finally disappearing; and the change of climate being conspicuous, we are tempted to attribute the whole effect to its direct action. But this is a false view; we forget that each species, even where it most abounds, is constantly suffering enormous destruction at some period of its life, from enemies or from competitors for the same place and food; and if these enemies or competitors be in the least favoured by any slight change of climate, they will increase in numbers; and as each area is already fully stocked with inhabitants, the other species must decrease. When we travel southward and see a species decreasing in numbers, we may feel sure that the cause lies quite as much in other species being favoured, as in this one being hurt. So it is when we travel northward, but in a somewhat lesser degree, for the number of species of all kinds, and therefore of competitors, decreases northwards; hence in going northwards, or in ascending a mountain, we far oftener meet with stunted forms, due to the directly injurious action of climate, than we do in proceeding southwards or in descending a mountain. When we reach the arctic regions, or snow-capped summits, or absolute deserts, the struggle for life is almost exclusively with the elements.

That climate acts in main part indirectly by favouring other species, we clearly see in the prodigious number of plants which in our gardens can perfectly well endure our climate, but which never become naturalised, for they cannot compete with our native plants nor ...

seems ... mals—often ensue; and here we have a limiting check independent of the struggle for life. But even some of these so-called epidemics appear to be due to parasitic worms, which have from some cause, possibly in part through facility of ...

... prey.

On the other hand, in many cases, a large stock of individuals of the same species, relatively to the numbers of its enemies, is absolutely necessary for its preservation. Thus we can easily raise plenty of corn and rape-seed, &c., in our fields, because the seeds are in great excess compared with the number of birds which feed on them; nor can the birds, though having a super-abundance of food at this one season, increase in number proportionally to the supply of seed, as their numbers are checked during the winter; but any one who has tried, knows how troublesome it is to get seed from a few wheat or other such plants in a garden: I have in this case lost every single seed. This view of the necessity of a large

any sensible degree The obvious explanation is that the conditions of life have been highly favourable and tl

r geometrical ratio of increase the result of which never fails to be surprising simply explains their extraordinarily rapid increase and wide diffusion in their new homes

In a state of nature almost every full grown plant annually produces seed and amongst animals there are very few which do not annually pair Hence we may confidently assert that all plants and animals are tending to increase at a geometrical ratio —that all would rapidly stock every station in which they could anyhow exist —and that this geometrical tendency to increase must be checked by destruction at some period of life Our familiarity with the larger domestic animals tends I think to mislead us we see no great destruction falling on them but we do not keep in mind that thousands are annually slaughtered for food and that in a state of nature an equal number would have somehow to be disposed of

The only difference between organisms which annually produce eggs or seeds by the thousand and those which produce extremely few is that the slow breeders would require a few more years to people under favourable conditions a whole district let it be ever so large The condor lays a couple of eggs and the ostrich a score and yet in the same country the condor may be the more numerous of the two the Fulmar petrel lays but one egg yet it is believed to be the most numerous bird in the world One fly deposits hundreds of eggs and another like the hippobosca a single one but this difference does not determine how many individuals of the two species can be supported in a district A large number of eggs is of some importance to those species which depend on a fluctuating amount of food for it allows them rapidly to increase in number But the real importance of a large number of eggs or seeds is to make up for much destruction at some period of life and this period in the great majority of cases is an early one If an animal can in any way protect its own eggs or young a small number may be produced and yet the average stock be fully kept up but if many eggs or young are destroyed many must be produced or the species will become extinct It would suffice to keep up the full number of a tree which lived on an average for a thousand years if a single seed were produced once in a thousand years supposing that this seed were never destroyed and could be ensured to germinate in a fitting place So that in all cases the average number of any animal or plant depends only indirectly on the number of its eggs or seeds

In looking at Nature it is most necessary to keep the foregoing considerations always in mind—never to forget that every single organic being may be said to be striving to the utmost to increase in numbers that each lives by a struggle at some period of its life that heavy destruction inevitably falls either on the young or old during each generation or at recurrent intervals Lighten any check mitigate the destruction ever so little and the number of the species will almost instantaneously increase to any amount

Nature of the Checks to Increase

The causes which check the natural tendency of each species to increase are most obscure Look at the most vigorous species by as much as it swarms in numbers by so much will it tend to increase still further We know not exactly what the checks are even in a single instance Nor will this surprise any one who reflects how ignorant we are on this head even in regard to mankind although so incomparably better known than any other animal This subject of the checks to increase has been ably treated by several authors and I hope in a future work to discuss it at considerable length more especially in regard to the feral animals of South America Here I will make only a few remarks just to recall to the reader's mind some of the chief points Eggs or very young animals seem generally to suffer most but this is not invariably the case With plants there is a vast destruction of seeds but from some observations which I have made it appears that the seedlings suffer most from germinat

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istance

on a piece of ground three feet long and two wide dug and cleared and where there could be no choking from other plants, I marked all the seedlings of our native weeds as they came up and out of 357 no less than 29 r de stroyed chiefly by slugs and insects If turf which has long been mown and the case would be the same with turf closely browsed by quadrupeds be let to grow the more vigorous plants gradually kill the less vigorous though

m

baanced, that the face of nature remains for f lo., periods of time unif rm though assuredly the merest trife would give th victory to ne organic beı,g er anoth Ne rth less, so profound is our gno ance and so high ur presumption, that w marv l when w hear of th extinction of an ranic being and as w d not see th cause, we in ke catacl m to desoate the world t law on the d ra tion of th f rms f lif

I am tempted t g e m re in tance showing how plants and animals rem t in the scale of nat re, are bound t g th r b a w b of complex relations. I shall h reafte ha occasion to show that th tic *Lobel f lgens* is r n ted my gard n by insects, and

to remo e their pollen masses and thus to fertilise them. I find from xperim nts that humble-bees are almost ind spensable to th fertilisation of th hea tsease (V *ol tricolor*) for othe bees d not isit this fl w I ha also found that th isits of bees are necessary for th f rtilisation f som kinds of lo f instance 0 head of D t h l (*T fol m*

produced .. 00 seeds, b t tl sam n mbe of protected heads produced not ingle seed. H mble-bees alo isit red clo e as oth r bees cannot reach th ectar It has been ug gested that m th ma f rtilise th lo ers but I d bt wh the th y could do so in th case of th red lo from tl ir w ght not bei g ffici t to depress th wing petals. Hence w m y inf as highl probabl that, if the whole genus of h mble-bees becam tinct or ry rare in England, th heartsease and red clo w ld becom ry rare or holly disappear Th mbe of humbl bees in any district depend in a gre t measure pon th numbe of fi ld mice, which destroy thei combs and ests and Col. Newman, who has long ttended to th hab ts f h mble-bees, believes that more than two-thirds of th m are thus destro ed all e E land N w th mber of mice is largel d pendent, as ry one knows, th mbe of cats and Col. Newman says, Near llages and mall towns I ha e found the nests f humble-bees m re num rous than else here which I ttrib t to the mber of cats that destroy th mice. Hence t is quit ceed ble that th presence f a

l hree numb rs in a d strict

In th case of very pecies, man checks, actin, t d ff rent periods of life, and d ring diff rent seaso s o ars, probably come into pla some on check or som few being g n rally th mo t potent b t all w ll concu in d termin g th a erage number r n th e istence of the speci s. In som cases it an be sh wn th t wid ly-different checks act n the same pec es n diff rent districts. Wh n w look t the plants and busl es cloth ing an ntangled bank, w are tempted to attrib te th r proport nal n mbers and kinds to what w call chance But h w false a view is this E y on has heard that wh n an American fore t is cut d wn a ry diff rent getati n prings up but t has been bserved that anci nt Ind an ruins in the south ern United States, which must f merly ha e been leared of trees, now displa th sam bea tiful di ers t and proporti n f kinds as in th surrounding irgin f re t. What a struggle must h e go on during long cen turies between th se eral kinds of trees acl ann ally scatt ring ts seeds by the th usand what war between nsect and insect—between insects, snails, and th animals w th bird and beasts of prey—all tri ng to rease all feeding ach th the trees, th r seeds and seedlings, n th ther plants which first lothed the ground and thu checked th growth of th trees! Throw up a handf l of f th rs, and all fall to the ground accordin to d fin t law b t h w simpl is th probl m wh re ach shall fall compared to th t f th action and reacti n of th innum abl plant and animals wh ch ha e d t r mined, in th course of ce turies, the propo tional numbers and kinds of trees n w growing n th ld I dian ruins

Th d pend ncy of one ganic being on an th as f parasit on ts prey h s gen erally between bein rem te in th scal of n ture. This is lik wise som times th case w th those which may be trictly said to tru, gl w th ach oth f exist nce as in th case of locusts and grass-feeding q adrupeds. B t th truggl will almost in ariably be most se between th indi d als f th sam pecies, f th y freq ent th sam distri ts, require th sam food and are exposed to th sam dangers. In th ase of var ties of th sam species, th truggle will generally be

stock of the same species for its preservation explains I believe some singular facts in nature such as that of very rare plants being sometimes extremely abundant in the few spots where they do exist and that of some social plants being social that is abounding in individuals even on the extreme verge of their range For in such cases we may believe that a plant could exist only where the conditions of its life were so favourable that many could exist together and thus save the species from utter destruction I should add that the good effects of intercrossing and the ill effects of close interbreeding no doubt come into play in many of these cases but I will not here enlarge on this subject

Complex Relations of all Animals and Plants to each other in the Struggle for Existence

Many cases are on record showing how complex and unexpected are the checks and relations between organic beings which have to struggle together in the same country I will give only a single instance which though a simple one interested me In Staffordshire on the estate of a relation where I had ample means of investigation there was a large and extremely barren heath which had never been touched by the hand of man but several hundred acres of exactly the same nature had been enclosed twenty five years previously and planted with Scotch fir The change in the native vegetation of the planted part of the heath was most remarkable more than is generally seen in passing from one quite different soil to another not only the proportional numbers of the heath plants were wholly changed but twelve species of plant (not counting grasses and carices) flourished in the plantations which could not be found on the heath The effect on the insects must have been still greater for six insectivorous birds were very common in the plantations which were not to be seen on the heath and the heath was frequented by two or three distinct insectivorous birds Here we see how potent has been the effect of the introduction of a single tree nothing whatever else having been done with the exception of the land having been enclosed so that cattle could not enter But how important an element enclosure is I plainly saw near Farnham in Surrey Here there are extensive heaths, with a few clumps of old Scotch firs on the distant hilltops within the last ten years large spaces have been enclosed and self sown firs are now springing up in multitudes so close together that all can not live When I ascertained that these young trees had not been sown or planted I was so much surprised at their numbers that I went to several points of view whence I could examine hundreds of acres of the unenclosed heath and literally I could not see a single Scotch fir except the old planted clumps But on looking closely between the stems of the heath I found a multitude of seedlings and little trees which had been perpetually browsed down by the cattle In one square yard at a point some hundred yards distant from one of the old clumps I counted thirty two little trees and one of them with twenty six rings of growth had during many years tried to raise its head above the stems of the heath and had failed No wonder that, as soon as the land was enclosed it became thickly clothed with vigorously growing young firs Yet the heath was so extremely barren and so extensive that no one would ever have imagined that cattle would have so closely and effectually searched it for food

Here we see that cattle absolutely determine the existence of the Scotch fir but in several parts of the world insects determine the existence of cattle Perhaps Paraguay offers the most curious instance of this for here neither cattle nor horses nor dogs have ever run wild though they swarm southward and northward in a feral state and Azara and Rengger have shown that this is caused by the greater number in Paraguay of a certain fly which lays its eggs in the navels of these animals when first born The increase of these flies numerous as they are must be habitually checked by some means probably by other parasitic insects Hence if certain insectivorous birds were to decrease in Paraguay the parasitic insects would probably increase and this would lessen the number of the navel frequenting flies—then cattle and horses would become feral and this would certainly greatly alter (as indeed I have observed in parts of South America) the vegetation this again would largely affect the insects and this as we have just seen in Staffordshire the insectivorous birds, and so onwards in ever increasing circles of complexity Not that under nature the relations will ever be as simple as this Battle within battle must be continually recurring with varying success and yet in the long run the forces are so nicely

Arctic regions n th b rders of an tte desert, w ll competit on ase Tl e land n y be extrem ly cold r dry y t the e w ll be competit b tween some f w spec s o be t een the d d l f th sam pec e fo the arm t damp t pots

If ce e can tl t wh n a plant r animal is placed n a n c unt y am g t compet tors, th d t of ts l f w ll g ally be chan ed n an ess t al man e alth h th hm t m y be actly the sa as in ts f m r hom If ts a r umb rs are t i rease n t e h me, w l o ld h to odify t in a d ff re t way to what sh ld ha had t d ts nat co t y f h uld h to g t som d an tag r d ff rent set f c pet t r or mies.

It is good thus to try in imaginat n to g ve t y ne pecie an ad antag o r an ther P obably n n i gl n ta ce h ld w kn w what t d Th ougl t to conv inc us of ou [illegible] th m t al r l t s f all o gan

[illegible]

is t ing to in rea e in a geom t cal o that ach at om pe od f its l f duri some eason of th y a du ing ach gen ra t n o at t als, l as t tr ggle f l fe a d to ff g t d tru t n Wh n w reflect on th s truggl w may co sole sel es th th f ll b l f tl at the w r f natu e s t nces ant, th t n f a f lt, that d th i g ner lly prompt d th t th g rou the healthy and tl h ppy s and m lt ply

almost equally severe and we sometimes see the contest soon decided for instance if several varieties of wheat be sown together and the mixed seed be re-sown some of the varieties which best suit the soil or climate or are naturally the most fertile will beat the others and so yield more seed and will consequently in a few years supplant the other varieties To keep up a mixed stock of even such extremely close varieties as the variously coloured sweet peas they must be each year harvested separately and the seed then mixed in due proportion otherwise the weaker kinds will steadily decrease in number and disappear So again with the varieties of sheep it has been asserted that certain mountain varieties will starve out other mountain varieties so that they cannot be kept together The same result has followed from keeping together different varieties of the medicinal leech It may even be doubted whether the varieties of any of our domestic plants or animals have so exactly the same strength habits and constitution that the original proportions of a mixed stock (crossing being prevented) could be kept up for half a dozen generations if they were allowed to struggle together in the same manner as beings in a state of nature and if the seed or young were not annually preserved in due proportion

Struggle for Life most severe between Individuals and Varieties of the same Species

As the species of the same genus usually have though by no means invariably much similarity in habits and constitution and always in structure the struggle will generally be more severe between them if they come into competition with each other than between the species of distinct genera. We see this in the recent extension over parts of the United States of one species of swallow having caused the decrease of another species The recent increase of the missel thrush in parts of Scotland has caused the decrease of the song thrush How frequently we hear of one species of rat taking the place of another species under the most different climates! In Russia the small Asiatic cockroach has everywhere driven before it its great congener In Australia the imported hive bee is rapidly exterminating the small stingless native bee One species of charlock has been known to supplant another species and so in other cases We can dimly see why the competition should be most severe between allied forms, which fill nearly the same place in the economy of nature but probably in no one case could we precisely say why one species has been victorious over another in the great battle of life

A corollary of the highest importance may be deduced from the foregoing remarks namely that the structure of every organic being is related in the most essential yet often hidden manner to that of all the other organic beings, with which it comes into competition for food or residence or from which it has to escape or on which it preys This is obvious in the structure of the teeth and talons of the tiger and in that of the legs and claws of the parasite which clings to the hair on the tiger's body But in the beautifully plumed seed of the dandelion and in the flattened and fringed legs of the water beetle the relation seems at first confined to the elements of air and water Yet the advantage of plumed seeds no doubt stands in the closest relation to the land being already thickly clothed with other plants so that the seeds may be widely distributed and fall on unoccupied ground In the water beetle the structure of its legs so well adapted for diving allows it to compete with other aquatic insects to hunt for its own prey and to escape serving as prey to other animals

The store of nutriment laid up within the seeds of many plants seems at first to have no sort of relation to other plants But from the strong growth of young plants produced from such seeds as peas and beans when sown in the midst of long grass it may be suspected that the chief use of the nutriment in the seed is to favour the growth of the seedlings whilst struggling with other plants growing vigorously all around

Look at a plant in the midst of its range why does it not double or quadruple its numbers? We know that it can perfectly well withstand a little more heat or cold dampness or dryness for elsewhere it ranges into slightly hotter or colder damper or drier districts In this case we can clearly see that if we wish in imagination to give the plant the power of increasing in number we should have to give it some advantage over its competitors or over the animals which prey on it. On the confines of its geographical range a change of constitution with respect to climate would clearly be an advantage to our plant but we have reason to believe that only a few plants or animals range so far that they are destroyed exclusively by the rigour of the climate Not until we reach the extreme confines of life in the

of the inhabitants, independently f th change of climate itself would seriously affect the others. If the country w re open n its borders, new forms would certainly imm rate and this would likewise seriously disturb the relations of some of th f rmer inhab tants. Let it be remembered how pow rf l th infl nce of single introduced tree o mammal has been shown t be B t in the case of an island, o of

better filled p, if som of the riginal inhabi tants were in som manner modified f had the area been pen to immigration, these same places would ha been seized on by intr d rs. In such cases, sl ght modificati ns, which in an way f voured th individuals f any species, by bett ad pting th m to thei altered conditions, ld t nd to be preserved and natural select w uld h ve free scope f th ork of impro ement.

W ha good reason to beli as h wn m th first hapt that chang s in the condi tions of lif gi t ndency to in reased aria bility and in th f re oin cases th co ditions ha chan ed, and this w uld manifestly be f ourable to natural selection, by aff rdin a

tions, t must er be f gotten that m re mu t d al diff re ces are incl ded. As man can prod ce gre t result with his d mesti animals and plants by adding p in any gi en direction ind vidual diff re ces, so could nat al selection, but far m re easil from ha in incomparabl longer t m f action. d I belie that any gre t ph sical han as f climat any al d ree f isolat to check imm gratio is ecessary in rd that ew nd occu p ed places l ld be left for nat ral select n to fill p b impro in some of the ar ing inhab tants. F as all th inhab tants of ach country are stru ling to g ther th nicel balanced f rces, tremely sl ght modifications in th tru ture o hab ts of ne pecies would oft gi t an ad antage er others and still further modifications f the same kind w uld often till furthe increase the ad antage, as lo as th pecies continued und the sam conditions of life and profited by similar means of subsistence and defence. No country can be named in hich all the nati e inhabitants are now so

perfectly adapted to each oth r and to the physical cond ti ns und r which they li e, that n of th m could be till bette adapted or impro ed fo in all co ntries, th natives ha been so far co quered by n turalised productions, that they have allowed some fore gn ers to tak firm possessi n of th land And as fore gn rs have thus in very country be ten som of th nati es, we m y safely conclude that the native might ha e been modified with ad antage so as to ha e better resisted th intrud rs.

As man can produce, and certainly has produ ced, a great result by his m thodical and unconscious m ans f selecti n what may n t nat ral se ection ffect Man can act only on external and isible charact rs Nature, if I may be allowed to personify the natural preservati n survi al of th fittest, cares noth ing f r ppearances, except in so far as they are useful to any being She can act on e ry internal organ, on ery shade of const tu ti nal diff re ce, n th wh l machin ry of life. Man selects only f his wn good N ture only f that f the being which sh t nds. Every selected character is fully ex rcised by her as is implied by th fact f th ir select on. Man keeps th natives of many climates in the same country h seldom rcises each selected character in som peculiar and fitting manner he feeds a long and a short beaked p eon on th same food h does n t ex rcise a long backed long legged quadruped in any peculiar mann h xposes sheep with lon and short wool to th sam climate. He does not allow th most rous mal to struggle f the f males. He doe n t rig dly destroy all inf rio animals, b t p tects during each varying season, as far as lies in his pow all his prod ctions. H ft n begins his selection by some half m nstrous f rm at least by som modification promin t no gh to catch th y or to be plainl useful t him. U d nature th sl htest diff rences f structure constitution may w ll turn th nicely balanced

how poo will be his results, compared w th those acc m lated by N ture during who e geological periods Can we w nd then, that N ture s p od tions sh uld be far tru in characte than man s productions that th y should be infinitely bett adapted to the most complex cond tions of life, and should plainly bear th stamp of far higher workmanship

CHAPTER IV

NATURAL SELECTION; OR THE SURVIVAL OF THE FITTEST

How will the struggle for existence, briefly discussed in the last chapter, act in regard to variation? Can the principle of selection, which we have seen is so potent in the hands of man, apply under nature? I think we shall see that it can act most efficiently. Let the endless number of slight variations and individual differences occurring in our domestic productions, and, in a lesser degree, in those under nature, be borne in mind; as well as the strength of the hereditary tendency. Under domestication, it may be truly said that the whole organisation becomes in some degree plastic. But the variability, which we almost universally meet with in our domestic productions, is not directly produced, as Hooker and Asa Gray have well remarked, by man; he can neither originate varieties, nor prevent their occurrence; he can preserve and accumulate such as do occur. Unintentionally he exposes organic beings to new and changing conditions of life, and variability ensues; but similar changes of conditions might and do occur under nature. Let it also be borne in mind how infinitely complex and close-fitting are the

useful to man have undoubtedly occurred, that other variations useful in some way to each being in the great and complex battle of life, should occur in the course of many successive generations? If such do occur, can we doubt (remembering that many more individuals are born than can possibly survive) that individuals having any advantage, however slight, over others, would have the best chance of surviving and of procreating their kind? On the other hand, we may feel sure that any

the destruction of those which are injurious, I have called Natural Selection, or the Survival of the Fittest. Variations neither useful nor injurious would not be affected by natural selection, and would be left either a fluctuating element, as perhaps we see in certain polymorphic species, or would ultimately become fixed, owing to the nature of the organism and the nature of the conditions.

Several writers have misapprehended or objected to the term Natural Selection. Some have even imagined that natural selection induces variability, whereas it implies only the preservation of such variations as arise and are beneficial to the being under its conditions of life. No one objects to agriculturists speaking of the potent effects of man's selection; and in this case the individual differences given by nature, which man for some object selects, must of necessity first occur. Others have objected that the term selection implies conscious choice in the animals which become modified; and it has even been urged that, as plants have no volition, natural selection is not applicable to them! In the literal sense of the word, no doubt, natural selection is a false term; but who ever objected to chemists speaking of the elective affinities of the various elements?—and yet an acid cannot strictly be said to elect the base with which it in preference combines. It has been said that I speak of natural selection as an active power or Deity; but who objects to an author speaking of the attraction of gravity as ruling the movements of the planets? Every one knows what is meant and is implied by such metaphorical expressions; and they are almost necessary for brevity. So again it is difficult to avoid personifying the word Nature; but I mean by Nature, only the aggregate action and product of many natural laws, and by laws the sequence of events as ascertained by us. With a little familiarity such superficial objections will be forgotten.

We shall best understand the probable course of natural selection by taking the case of a country undergoing some slight physical change, for instance, of climate. The proportional numbers of its inhabitants will almost immediately undergo a change, and some species will probably become extinct. We may conclude, from what we have seen of the intimate and complex manner in which the inhabitants of each country are bound together, that any change in the numerical proportions

an insect to a score f continge ci s, wh lly du rent from those wh ch co cern tl m ture insect and these modificati ns may affect, thro gh correlation, th tru ture f the adult. So, co rsel modific tions in the d lt m y a ct th tract re f the lar b t all cases natural selectio will nsure that th y hall n t be injurious f if th y w re so the pecies ould become extin t.

N tural selecti ll modify the tru ture of th un in relat n t th pare t, and f th parent in relat to the y ung In social m l t w ll dapt th tru t re f ch in

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without gi ing t any ad antag f tl good of another speci and th gh tat ments to h ffect m be f d in w ks of tural

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th th gg wh h had th m t pow rful and hardest beaks, f all w th w ak be ks ld t bly p n l m d l t and m re asil brok h lls m ght b selected, tl th ki s f th l ll be g kn n t ary lik n tl tru t

It m be w ll h re t m k th t th all fu gs tl must be m ch f t t d truc- tion, wl ch an h l tl uffi ce th ourse f nat al selecti n. F in tance a ast mbe f eg seed are an ll de- vour d, and th se co ld be mod fi l tl ro gh nat al sel ctio ly f tl d som mann wl ich protect d tl m f m tl e- m s. Y t many f tl se g seed ld perhaps, if not d tro ed l l led f d als b tt adapt l t tl co d t f l f than any of th se l h l ppe ed t rv e. So again ast mbe f mature an mals and plants, wh ther or n t they be the best adapt ed to tl r co d t ns, must b annually de- troyed by acc dental causes which w uld n t be the l ast d gree mit gated by certain t t wh ch

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district b n t wh lly k pt down by s ch ca ses,— r g n l t th destr t on f ggs r eeds b so gre t that nly a h ndredth a th sandth p rt are d l ped —y t of th se wh h d s e, th b t ad pted individuals s ppo g th t th re i any ari b lity n a f v ur bl d re t w ll t nd to propagate the ki d in larg numbers than tl e l ss w ll ad pted If tl n mbers b wh lly k pt d wn by tl e se ju t d cated as w ll often h been th case n t al elect on will be po r l ss ertain b fi l d rect ns b t this is n alid object n to ts ffi n y t th t m and n oth w ys f are f r from h ng y re so to ppose that many pe- es und g mod fi at on and impro e- m nt at th same tim in th same area.

Sexu l Selection

I asm h as pecul rit es oft n appear un d d m t ti n m sex and become h red taril ttached to th t sex so no d bt t w ll b d n ture. Th it is nd ed pos bl f th t o se es to b mod fied thro l nat al lect n in lat n t diff t l b t f lif as is som t m th ase f e se t be modified n rel t n to th th ex as comm nly occ s. This leads m to say a f w w rd on what I h alled Se al Select This f m f selecti n d pe d t a tru gl fo st nce n rel ti to th g nc bein to t l con d ti b t a t gl b tw n th ind d ual f g lly th mal s, fo the posse n f th th se Tl re lt is n t death to tl un ccessf l compet t but f w

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pro B t many c ses, t ry d pe d n t so m l n g ral g as n ha pec al w po confi ed to tl m l x. A h nl ss t g p l ss cock w ld h poo l ar e f l g n m ro s ff p Se ual sel ct n, by l y all w g th t to breed m ht rely g d m tabl co ag length to th pur and tre gth to the

It may metaphorically be said that natural selection is daily and hourly scrutinising throughout the world the slightest variations rejecting those that are bad preserving and adding up all that are good silently and insensibly working *whenever and wherever opportunity offers* at the improvement of each organic being in relation to its organic and inorganic conditions of life We see nothing of these slow changes in progress until the hand of time has marked the lapse of ages and then so imperfect is our view into long past geological ages that we see only that the forms of life are now different from what they formerly were

In order that any great amount of modification should be effected in a species a variety when once formed must again perhaps after a long interval of time vary or present individual differences of the same favourable nature as before and these must be again preserved and so onwards step by step Seeing that individual differences of the same kind perpetually recur this can hardly be considered as an unwarrantable assumption But whether it is true we can judge only by seeing how far the hypothesis accords with and explains the general phenomena of nature On the other hand the ordinary belief that the amount of possible variation is a strictly limited quantity is likewise a simple assumption

Although natural selection can act only through and for the good of each being yet characters and structures which we are apt to consider as of very trifling importance may thus be acted on When we see leaf eating insects green and bark feeders mottled grey the alpine ptarmigan white in winter the red grouse the colour of heather we must believe that these tints are of service to these birds and insects in preserving them from danger Grouse if not destroyed at some period of their lives would increase in countless numbers they are known to suffer largely from birds of prey and hawks are guided by eyesight to their prey —so much so that on parts

effective in giving the proper colour to each kind of grouse and in keeping that colour when once acquired true and constant Nor ought we to think that the occasional destruction of an animal of any particular colour would produce little effect we should remember how essential it is in a flock of white sheep to destroy a lamb with the faintest trace of black We have seen how the colour of the hogs which feed on the paint root in Virginia determines whether they shall live or die In plants the down on the fruit and the colour of the flesh are considered by botanists as characters of the most trifling importance yet we hear from an excellent horticulturist Downing that in the United States, smooth skinned fruits suffer far more from a beetle a Curculio than those with down that purple plums suffer far more from a certain disease than yellow plums whereas another disease attacks yellow fleshed peaches far more than those with other coloured flesh If with all the aids of art these slight differences make a great difference in cultivating the several varieties assuredly in a state of nature where the trees would have to struggle with other trees and with a host of enemies such differences would effectually settle which variety whether a smooth or downy a yellow or purple fleshed fruit should succeed

In looking at many small points of difference between species which as far as our

effect It is also necessary to bear in mind that owing to the law of correlation when one part varies and the variations are accumulated through natural selection other modifications, often of the most unexpected nature will ensue

As we see that those variations which under domestication appear at any particular period of life tend to reappear in the offspring at the same period —*for instance in the shape size* and flavour of the seeds of the many varieties of our culinary and agricultural plants in the caterpillar and cocoon stages of the varieties of the silk worm in the eggs of poultry and in the colour of the down of their chickens in the horns of our sheep and cattle when nearly adult —so in a state of nature natural selection will be enabled to act on and modify organic beings at any age by the accumulation of variations profitable at that age and by their inheritance at a corresponding age If it profit a plant to have its seeds more and more widely disseminated by the wind I can see no greater difficulty in this being effected through natural selection than in the cotton planter increasing and improving by selection the down in the pods on his cotton trees Natural selection may modify and adapt the larva of

dee and the oth m re bulky with sh rter legs, h h more frequ tly att cks tl e sh p-herd flocks.

It sl ld be bserved that in tl bove illustration, I peak f tl e slimme t indi idual wol es, and not cf any s gl tro ly marked ariatio h in bee pre rved In f rm r edi ions of this wo k I som t mes pok as if this latter alt rnati e had f qu tly occ rred I saw the gre t mportance f d dual d ffe nces, and th led m f lly t d scuss th re sults of unconsc selecti by man wh ch d pends tl e preser ati n f all the m re or less al abl i di id ls, and n the d truc t f th rst I saw also tl t the prese

l h l se-

I d d t ppreciat how arely gl ar a- tions, h th sl ght tro gl marked co ld be perpet ted Th a tl take th case of a pair f animals, prod l their lif tim tw h lred ff pri g f h l from no se f d tri t l t an

a ug uu

rations. Tl j tr e f tl se rem ks ann t, I think be d p ted If f t ce b rd f som kind co ld proc t food in as ly by ha g ts be k ed and f w re born th ts beak tro gly ed d wh h conseq ty fl rished, n th l ss tl ere uld be a ry poo chance f this in di l al perpetu ting ts k l to tl lus n of the commo f rm b t th re ar l rdly be d lt j dg by wl t w see tak g place

the destruct on of a t ll larg r number with the str l ks

It sh certain wh ch differe o ganisat on be im larly acted o —of wl ch fact um rou nstances could be g ven w th u domest c produ t ons In su h ases, f the vary n nd vidual d d n t act ally transm t to its offspri g its newly-acqu red charact t w uld und ubtedly tran mit to them as l ng as the e i ting ond ti ns re mai ed tl sam a till tro ger t nden y to v y n the same mann Th re can also be l l tl t d n y to a y in the

of select n. O nly a third fifth o tenth part f the ind l al may h been thus ffected of wl l fact se eral n.t nce co ld

t

f m ly ranked as a u p n m of *Ursa lac ym s* I cases f tl s kind if tl ar ti w re f b f cial n ture th g lf m w ld soon b s pplanted by th mod fied fo m thro gh th l f the fittest

T the ffects f n tercros ing in eliminating ariat f all kinds, I h ll h to ecur but t may b h re rem rked th t m t animals and plant k ep to th r prope h m s, and do n t eedl ssly wand b ut we see tl e n w th m grat ry b rds, wh ch almost al ys re t t th sam pot. Conseq tly ach n w ly f med n ty w ld g rally be t first loc l as see ns t be th comm n l w th ar t cs tat f n t re so th t im larly mod fied l id ls w uld oon ist a m ll bod t g th and w ld ft n breed to-g tl If tl n n t were ccessf l its b ttl f l f t w ld l ly pread f m a ce t l d t t, competing w tl d o g tl har d d d al n th argins of an asi rel

It m y b w rth wl l to gi e an tl and m re ompl ll trat n f th act on f na-tu l sel ct n C ta n plants ret weet j ce pp re tly f th sak f eliminati g som tl g inj n from th sap this is ffected f tance, by gl d t th base of th t p l som Legum osæ and t the back f th l a f th comm n la l. Th s

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wing to strike in the spurred leg in nearly the same manner as does the brutal cockfighter by the careful selection of his best cocks How low in the scale of nature the law of battle descends I know not male alligators have been described as fighting bellowing and whirling round like Indians in a war-dance for the possession of the females male salmons have been observed fighting all day long male stag *beetles sometimes bear wounds from the huge* mandibles of other males the males of certain hymenopterous insects have been frequently seen by that inimitable ob erver M Fabre fighting for a particular female who sits by an apparently unconcerned beholder of the struggle and then retires with the conqueror The war is perhaps severest between the males of polygamous animals and these seem oftenest provided with special weapons The males of carnivorous animals are already well armed though to them and to others pecial means of defence may be given through means of sexual *selection as the mane of the lion and the* hooked jaw to the male salmon for the shield may be as important for victory as the sword or spear

Amongst birds the contest is often of a more peaceful character All those who have attended to the subject believe that there is the severest rivalry between the males of many *species to attract by singing the females* The rock thru h of Guiana birds of paradise and some others congregate and succe sive males

females which standing by as spectators at

has described how a pied peacock was eminently attractive to all his hen bird I cannot here enter on the necessary details but if man can in a short time give beauty and an elegant carriage to his bantams according to his standard *of beauty* I can see no good reason to doubt that female birds by selecting during thousands of generations the most melod ous or beautiful males *according to their standard* of beauty might produce a marked effect

be explained through the action of sexual selection on variations occurring at different ages and transmitted to the males alone or to both *sexes at corresponding ages* but I have not space here to enter on this subject

Thus it is as I believe that when the males and females of any animal have the same general habits of life but differ in structure col our or ornament such differences have been mainly caused by sexual selection that is, by individual males having had in successive *generations* some slight advantage over other males in their weapons means of defence or charms, which they have transmitted to their

arising and becoming attached to the male sex which apparently have not been augmented *through selection by man* The tuft of hair on the breast of the wild turkey-cock cannot be of any use and it is doubtful whether it can be ornamental in the eyes of the female bird — indeed had the tuft appeared under do*mestication it would have been called a mon*strosity

Illustrations of the Action of Natural Selection or the Survival of the Fittest

In order to make it clear how as I believe natural selection acts I must beg permission to give one or two imaginary illustrations Let *us take the case of a wolf which preys on vari*ous animals securing some by craft some by strength and some by fleetness and let us suppose that the fleetest prey a deer for instance had from any change in the country increased in numbers or that other prey had decreased in numbers during that season of the year when the wolf was hardest pressed for *food* Under *such circumstances* the swiftest and slimmest wolves would have the best chance of surviving and so be preserved or se*lected* —provided always *that* they *retained* strength to master their pr y at this or some other period of the year wh n they ere compelled to prey on other animals I can see no more reason to doubt that this would be the result than that man should be able to improve the fleetness of his greyhounds by careful and methodical selection or by that kind *of unconscious selection which follows from* each man trying to keep the b t dogs ith ut any thought of modifying the breed I may *add that according to* Mr Pierce there are two varieties of the wolf inhabiting the Catskill Mountains in the United States one with a light greyhound like form which pursues

bee or other insect, so that certain indi iduals could be able to obtain their food m re quick ly than others and thus the communities to which they belonged would fl urish and throw off many swarms inh riting th same peculiar ties. The tubes of th corolla f th comm n red and incarnate clo rs (*Trifol m pratense* and *incarnatum*) d not n hasty glance appear to diff r in length t th hi e-bee can easil suck the nectar t of th incarnat clover b t not o t of th comm red clo r which is visited b h mble-bees al n so that whole fields of red lo ff in vain an abundant supply of precious ectar to th hi e-bee. That this nectar is much liked b th hi e-bee certain I ha repeatedly seen, b t only n the tumn, many hi e-bees sucking the flowers through h le b tten in th base f the tu b h mble-bees. Th differe ce in the length of the corolla th tw kinds of clov r which d termines th isits f th hi bee must be ery triflin f I ha been assured that when red clo has been mown, th flo rs of the second crop are som what mal er and that these are visited by many hi e-bees. I do not know wh th this stat m nt is accurat nor wheth anoth published statement can be trusted, nam l that th Ligurian bee hich is generally considered a m re ari ty of the commo hi -bee and which freely crosses th t, is able to reach and uck the nectar of the red lo er Thus, in a country here this kind of clo er abounded, t might be great ad antage to the hi e-bee to ha a slightly longe or diff rentl constru ted proboscis. On the other hand, as th f rtilit of this lo er absol tel depends on bees isiting the flowers, if humble bees w re to becom rare in any country t m ght be great ad antage to the plant to ha a short m re deepl divided corolla, so that th hi e-bees would be enabled to suck ts flow rs. Thus I can und rstand how fl nd bee might slo ly becom eith simultaneously a t the other modified and adapted to ach other in the most perfect mann by th continued preservatio of all th ndi iduals hich prese ted slight d iat ns of tructure m tually f ourable to each the

I am w ll ware that this doctrine of natural selection, xemplified in th abo maginary instances, is ope to th sam objections which re first urged against Sir Charles Ly ll noble iew on the mod rn changes of the earth, as illustrati e of geology b t w now seldom hear the agencies which w see still at w k, spok n f as trifling or insignificant, when used in explaining the excav tion of the deepest vall ys o the fo mati n of lo lines of inland cliffs. Natural selection acts only by the preservati n and accum lation of mall inherited modifications, each profitable to the preserved being and as modern geology has almost banished such views as th excavation f a great vall y by a single diluvial w so will natural selection banish the beli f of the continued creati n of new organic beings, or f any gre t and sudd n modification in their tructure

On the I terc ossing of Individuals

I must h re introduce a sh rt d gression. In th case f an mals and plant w th separated se es, t is of course ob ou that two ind vid uals must alwa (with th e cepti n of th curio and not w ll und rstood cases of parth ge esis) unite f each birth b t in th case of h rm phrod tes this is far from obvious. N rth less th re is reason to belie that w th all h rmaphrodites tw indi iduals, eith occasionally hab t all co cur for th reproduction of th ir kind. This vi w was

ma rais p partu

All ertebrate animals, all insects, and som oth r large gro ps of animals, pair f each birth. Mod rn research has much diminished th numbe of pposed h rm phrodites, and of real h rmaphrodites larg numbe pair that is, two indi iduals regularl unit f reproduction, which is all that concerns us. B t still th re are many h rmaphrodite animals which certainly d n t hab tuall pair and a vast m jority f plants are h rmaphrodites. What reason, t ma be asked, is there f supposing in these cases that tw indi duals co cur in reprod tion As t is impossible h re t nte d tails, I must trust to som g n ral considerations alo e.

In th first place I ha collected so large a body f facts, and made so many experi ments, sh w g ccordance with th alm t uni rsal beli f breed rs, th t with animals and plants ross bet een d ff re t vari ties, or between indi iduals f th sam ari ty b t of anoth train, g es vour and f rtility to th off pring and th th hand, that *close* interbreedin, d minishes g and f tilit that these facts alo inclin m to be-

juice though small in quantity is greedily sought by insects but their visits do not in any way benefit the plant Now let us suppose that the juice or nectar was excreted from the inside of the flowers of a certain number of plants of any species Insects in seeking the nectar would get dusted with pollen and would often transport it from one flower to another The flowers of two distinct individuals of the same species would thus get crossed and the act of crossing as can be fully proved gives rise to vigorous seedlings which consequently would have the best chance of flourishing and surviving The plants which produced flowers with the largest glands or nectaries excreting most nectar would oftenest be visited by insects and would oftenest be crossed and so in the long run would gain the upper hand and form a local variety The flowers also which had their stamens and pistils placed in relation to the size and habits of the particular insects which visited them so as to favour in any degree the transportal of the pollen would likewise be favoured We might have taken the case of insects visiting flowers for the sake of collecting pollen instead of nectar and as pollen is formed for the sole purpose of fertilisation its destruction appears to be a simple loss to the plant yet if a little pollen were carried at first occasionally and then habitually by the pollen-devouring insects from flower to flower and a cross thus effected although nine tenths of the pollen were destroyed it might still be a great gain to the plant to be thus robbed and the individuals which produced more and more pollen and had larger anthers would be selected

When our plant by the above process long continued had been rendered highly attractive to insects they would unintentionally on their part regularly carry pollen from flower to flower and that they do this effectually I could easily show by many striking facts I will give only one as likewise illustrating one step in the separation of the sexes of plants Some holly trees bear only male flower which have four stamens producing a rather small quantity of pollen and a rudimentary pistil

tree exactly sixty yards from a male tree I put the stigmas of twenty flower taken from different branches under the microscope and on all, without exception there were a few pollen grains and on some a profusion As the wind had set for several days from the female to the male tree the pollen could not thus have been carried The weather had been cold and boisterous and therefore not favourable to bees, nevertheless every female flower which I examined had been effectually fertilised by the bees, which had flown from tree to tree in search of nectar But to return to our imaginary case as soon as the plant had been rendered so highly attractive to insects that pollen was regularly carried from flower to flower another process might commence No naturalist doubts the advantage of what has been called the physiological division of labour hence we may believe that it would be advantageous to a plant to produce stamens alone in one flower or on one whole plant and pistils alone in another flower or on another plant In plants under culture and placed under new conditions of life sometimes the male organs and sometimes the female organs become more or less impotent now if we suppose this to occur in ever so slight a degree under nature then as pollen is already carried regularly from flower to flower and as a more complete separation of the sexes of our plant would be advantageous on the principle of the division of labour individuals with this tendency more and more increased would be continually favoured or selected until at last a complete separation of the sexes might be effected It would take up too much space to show the various steps through dimorphism and other means by which the separation of the sexes in plants of various kinds is apparently now in progress but I may add that some of the species of holly in North America are according to Asa Gray in an exactly intermediate condition or as he expresses it are more or less diœciously polygamous

Let us now turn to the nectar feeding insects we may suppose the plant of which we have been slowly increasing the nectar by continued selection to be a common plant and that certain insects depended in main part on its nectar for food I could give many facts showing how anxious bees are to save time for instance their habit of cutting holes and sucking the nectar at the bases of certain flowers which with a very little more trouble they can enter by the mouth Bearing such facts in mind it may be believed that under certain circumstances individual differences in the curvature or length of the proboscis, &c too slight to be appreciated by us might profit a

pollen of a distinct variety having a prepotent effect over the flower's own pollen, and that this is part of the general law of good being derived from the intercrossing of distinct individuals of the same species. When distinct species are crossed the case is reversed, for a plant's own pollen is almost always prepotent over foreign pollen; but to this subject we shall return in a future chapter.

tree, and at most only from flower to flower on the same tree; and flowers on the same tree can be considered as distinct individuals only in a limited sense. I believe this objection to be valid, but that nature has largely provided against it by giving to trees a strong tendency to bear flowers with separated sexes. When the sexes are separated, although the male and female flowers may be produced on the same tree, pollen must be regularly carried from flower to flower; and this will give a better chance of pollen being occasionally carried from tree to tree. That trees belonging to all Orders have their sexes more often separated than other plants, I find to be the case in this

...an trees are dichogamous, the same result would follow as if they bore flowers with separated sexes. I have made these few remarks on trees simply to call attention to the subject.

Turning for a brief space to animals: various terrestrial species are hermaphrodites, such as the land mollusca and earth-worms; but these all pair. As yet I have not found a single terrestrial animal which can fertilise itself. This remarkable fact, which offers so strong a contrast with terrestrial plants, is intelligible on the view of an occasional cross being indispensable, by considering the nature of the fertilising element; there are no means, analogous to the action of insects and of the wind with plants, by which an occasional cross could be effected with terrestrial animals without the concurrence of two individuals. Of aquatic animals, there are many self-fertilising hermaphrodites; but here the currents of water offer an obvious means for an occasional cross. As in the case of flowers, I have as yet failed, after consultation with one of the highest authorities, namely Professor Huxley, to discover a single hermaphrodite animal with the organs of reproduction so perfectly enclosed that access from without, and the occasional influence of a distinct individual, can be shown to be physically impossible. Cirripedes long appeared to me to present, under this point of view, a case of great difficulty; but I have been enabled, by a fortunate chance, to prove that two individuals, though both are self-fertilising hermaphrodites, do sometimes cross.

It must have struck most naturalists as a strange anomaly that, both with animals and plants, some species of the same family and even of the same genus, though agreeing closely with each other in their whole organisation, are hermaphrodites, and some unisexual. But if, in fact, all hermaphrodites do occasionally intercross, the difference between them and unisexual species is, as far as function is concerned, very small.

From these several considerations and from the many special facts which I have collected, but which I am unable here to give, it appears that with animals and plants an occasional intercross between distinct individuals is a very general, if not universal, law of nature.

Circumstances favourable for the production of new forms through Natural Selection

This is an extremely intricate subject. A great amount of variability, under which term individual differences are always included, will

...tum of the work of natural selection, as does not grant an indefinite period of... as all organic beings are striving to seize on each place in the economy of nature, if any one species does not become modified and improved in a corresponding degree with its competitors, it will be exterminated. Unless favourable variations be inherited by some at least of the offspring, nothing can be effected by natural selection. The tendency to reversion may often check or prevent the work; but as this tendency has not prevented man from forming by selection numerous domestic races, why should it prevail against natural selection?

In the case of methodical selection, a breeder selects for some definite object, and if the

lieve that it is a general law of nature that no organic being fertilises itself for a perpetuity of generations but that a cross with another individual is occasionally—perhaps at long intervals of time—indispensable

On the belief that this is a law of nature we can I think understand several large classes of facts such as the following which on any other view are inexplicable Every hybridizer knows how unfavourable exposure to wet is to the fertilisation of a flower yet what a multitude of flowers have their anthers and stigmas *fully* exposed to the weather! If an occasional cross be indispensable notwithstanding that the plant s own anthers and pistil stand so near each other as almost to insure self fertilisation the fullest freedom for the entrance of pollen from another individual will explain the above state of exposure of the organs *Many flowers on the other hand* have their organs of fructification closely enclosed as in the great papilionaceous or pea family but these almost invariably present beautiful and curious adaptations in relation to the visits of insects So necessary are the visits of bees to many papilionaceous flowers that their fertility is greatly *diminished if these visits be prevented* Now it is scarcely possible for insects to fly from flower and flower and not to carry pollen from one to the other to the great good of the plant. Insects act like a camel hair pencil and it is sufficient to ensure fertilisation just to touch with the same brush the anthers *of one flower and then the stigma of another* but it must not be supposed that bees would thus produce a multitude of hybrids between distinct species for if a plant s own pollen and that from another species are placed on the same stigma, the former is so prepotent that it invariably and completely destroys as *has been shown by* Gartner the influence of the foreign pollen

When the stamens of a flower suddenly spring towards the pistil or slowly move one after the other towards it, the contrivance seems adapted *solely* to ensure *self fertilisation* and no doubt it is useful for this end but the agency of insects is often required to cause the stamens to spring forward as Kolreuter has shown to be the case with the barberry and in this very genus, which seems to have a special contrivance for self fertilisation it is *well known that, if closely* allied forms or varieties are planted near each other it is hardly possible to raise pure seedlings, so largely do they naturally cross In numerous other cases, far from *self fertilisation being* favoured there are special contrivances which effectually prevent the stigma receiving pollen from its own flower as I could show from the works of Sprengel and others as well as from my own observations for instance in *Lobelia fulgens* there is a really beautiful and elaborate contrivance by which all the *infinitely numer*ous pollen granules are swept out of the conjoined anthers of each flower before the stigma of that individual flower is ready to receive them and as this flower is never visited at least in my garden by insects it never sets a seed though by placing pollen from one flower on the stigma of another I raise plenty of seedlings Another species of *Lobelia* which is visited by bees seeds freely in my garden In very many other cases though there is no special mechanical contrivance to prevent the stigma receiving pollen from the same flower yet as Sprengel and more recently Hildebrand and others have shown and as I can confirm either the anthers burst before the stigma is ready for fertilisation or the stigma is ready before the pollen of that flower is ready so that these so named dichogamous *plants have in fact separated sexes and must* habitually be crossed So it is with the reciprocally dimorphic and trimorphic plants previously alluded to How strange are these facts! How strange that the pollen and stigmatic surface of the same flower though placed so

these facts explained on the view of an occasional cross with a distinct individual being advantageous or indispensable!

If several varieties of the cabbage, radish onion and of some other plants be allowed to seed near each other a large majority of the seedlings thus raised turn out as I have found mongrels for instance I raised 233 seedling cabbages from some plants of different varieties growing near each other and of these only *78 were true to their kind and some even of* these were not perfectly true Yet the pistil of each cabbage flower is surrounded not only by its own six stamens but by those of the many other flowers on the same plant and the *pollen of each flower readily gets on its own* stigma without insect agency for I have found that plants carefully protected from insects produce the full number of pods. How then comes it that such a vast number of the seedlings are mongrelized *It must arise from the*

n polle is almost always prepot f n gn poll b t to th s s bject w hall h t r

to bear fl ers th separated se es. Wl tl sexes are sep rated alth gh tl m l and f mal fl rs m y be prod ced the same tree poll must b reeul ly carried from fl to fl e and th s w ll g b tt

t an th pla ts, I d t b ... ml t

ian trees are dich gam s, th sam ult w uld f llow as if th y bore fl w rs w th sepa rated se es. I ha mad these f w remarks trees simply t call tt tio t th bject.

Turning f bri f pace to animals arious terrestrial pec es are h rmaphrod tes, uch as th land mollusca and earth w rm b t these all pair As y t I ha t f und singl t restrial an mal hich can f rtilise tself This remarkable fact, which ff rs so tro a contrast w th terrestrial plants, is t ll nbl n th iew of an occasi nal cross bei indispensable f ing t the nat re f th f rtilising lem t there are means, analo us to th actio of insects and of the wind with plants, by which an occasional ross co ld be eff cted th terrestrial an mals with t th concurrence of tw indi iduals. Of aquatic animals, there are man self f rtilizin h rmaphrodites b t here th curre ts of w te ffer an ob ious means for an occasional cross. As in the case of flowers, I have as y t failed, after consultation th ne of the highest authori- ti s, am l Professor Huxley t disco er a s gle h rmapl rod t animal w th th org ns f re rod t n so perfectly cl sed that ac

pe red to me to prese t u d r th s po t o vi w a case of great difficulty but I h e been n bled by a f t nat chance t pro that tw ind du ls, tl l botl a self fert l sing h rm pl od tes, d som t m cross

It m t l truck mo t n t alists as a trange an maly that, both with animals and pla ts, som pec s of th sam fam ly and e n f tl same gen s, th ugh gree g closely w th ach tl in th wh le ganisa t n, are h maph od tes, and som unisexual. B t f f t, ll h rm phrod tes d occas n ally t rcross, tl d fference b tween them and un se al peci is, as far as funct n s co cerned y small.

th t w th animals and plants an occas al int rcross betwee distin t indi du ls is a ry ene al, if n t uni rsal, law f nature

Ci cumstanc s favourable for tl e production of new forms th ough Natural Selectio

is, I beli highly mportant l ment f success. Th gh N ture g ants l pe od f tim f th w k f natu al selection, sh does n t grant an ind fi t period f as all o gan c bein are stri to seize n each place in the eco my f nature if any pec does n t becom mod fied and impro ed in a co re spond g d gree with ts compet tors, t w ll b ext rm ted Unles f bl n t i ns be inh rited by som t l ast f th off prin n thing be ffected by natu al select n Th te d cy to re rs may ft n heck pre ent the w k b t as this tend cy has not pre ted man from f rm g by select n n m rous d mesti races, why sh uld t preail against natural select n

In th case f m thod cal selecti a breed er selects f som definite object, and if the

individuals be allowed freely to intercross his work will completely fail But when many men without intending to alter the breed have a nearly common standard of perfection and all try to procure and breed from the best animals improvement surely but slowly follows from this unconscious process of selection notwithstanding that there is no separation of selected individuals Thus it will be under nature for within a confined area with some place in the natural polity not perfectly occupied all the individuals varying in the right direction though in different degrees will tend to be preserved But if the area be large its several districts will almost certainly *present different conditions of life* and then if the same species undergoes modification in different districts the newly formed varieties will intercross on the confines of each But we shall see in the sixth chapter that intermediate varieties inhabiting intermediate districts *will in the long run generally be supplanted by* one of the adjoining varieties Intercrossing will chiefly affect those animals which unite for each birth and wander much and which do not breed at a very quick rate Hence with animals of this nature for instance birds varieties will generally be confined to separated countries and this I find to be the case

on any one spot and might there maintain itself in a body and afterwards spread so that the individuals of the new variety would chiefly cross together On this principle nurserymen always prefer saving seed from a large body of plants as the chance of intercrossing

always eliminate the effects of natural selection for I can bring forward a considerable body of facts showing that within the same area two varieties of the same animal may long remain distinct from haunting different stations from breeding at slightly different seasons or from the individuals of each variety preferring to pair together

Intercrossing plays a very important part in nature by keeping the individuals of the same species or of the same variety true and uniform in character It will obviously thus act far more efficiently with those animals which unite for each birth but as already stated we have reason to believe that occasional intercrosses take place with all animals and plants Even if these take place only at long intervals of time the young thus produced will gain so much in vigour and fertility over the offspring from long continued self fertilisation that they will have a better chance of surviving and propagating their kind and thus in the long run the influence of crosses even at rare intervals will be great With respect to organic beings extremely low in the scale which do not propagate sexually nor conjugate and which *cannot possibly intercross uniformity of character can be retained by them under* the same conditions of life only through the principle of inheritance and through natural selection which will destroy any individual departing from the proper type If the conditions of life change and the form undergoes *modification uniformity of character can be* given to the modified offspring solely by natural selection preserving similar favourable variations

Isolation also is an important element in the modification of species through natural selection In a confined or isolated area, if not very large the organic and inorganic conditions of life will generally be almost uniform so that natural selection will tend to modify all the varying individuals of the same species in the same manner Intercrossing with the inhabitants of the surrounding districts will also be thus prevented Moritz Wagner has lately published an interesting essay on this subject and has shown that the service rendered by isolation in preventing crosses between newly formed varieties is probably greater even than I supposed But from reasons already assigned I can by no means agree with this naturalist that migration and isolation are necessary elements for the formation of new species The importance of isolation is likewise great in preventing after any physical change in the conditions such as of climate elevation of the land &c the immigration of better adapted organisms and thus new places in the natural economy of the district will be left open to be filled up by the modification of the old inhabitants Lastly isolation will give time for a new variety to be improved at a slow rate and this may sometimes be of much importance If however an isolated area be very small either from being surrounded by barriers or from having very

peculiar physical conditions, the total number of the inhabitants will be mall and this will retard the production of n w pecies through natural selection, by decreasing the chances of favourable variations arisin

The mere lapse of tim by itself does nothing, either *for* or against natural selection. I state this because t has been rro eousl asserted that th l ment of tim has been assumed b me to play an all-important part n m fy species, as if all th forms of life

as great, and

ficial ariations arising and of their bein selected, accumulated, and fixed. It lik wise tends to increase th direct action of the physical conditions of lif in relation to the constit tio of each organism.

If w turn t nature to test th truth of these remarks, and look t an small solated area, such as an oceanic island, altho gh th umber of species inhabiting t is mall, as we shall see in our chapt on Geographical Distribution t of these species a very large proportion are end mic—that is, have been produced there and nowhere else in th world. Hence an oceanic island at first sight seems to ha been highly f ourable for the prod c tion of new species. B t we may thus decei ourselves, for to ascertain wh ther a small isolated area, or larg open area like a co tinent has been most f ourable for th production of new organic forms, w ought t make th comparison within equal times and this we are incapable of doing.

Although solation is of great importance in the production of new species, on th whol I am inclined to belie that largeness of area is still more important, especiall for th produc tion of species which shall prove capable of enduring f long period, and of spreading widel Throughout a great and open area, not onl will th re be bette chance of f vourable ariations, arising from the large number of indi iduals of the sam species there supported, but the conditions of lif are much more comple from th larg number of already existing species and if som of these many species becom modified and impro ed, others will have to be improved in corresponding egree, or they will be exterminated. Each new form, also, as soon as t has been much impro ed, ill be able to pread o er the open and continuous area, and will thus come into competition with many other forms. Moreo er great areas, though n w continuous, will often, owing to former oscillations of level, have xi ted in broken condition so that th good ffects of isolation will generally to a certain extent, have concurred Finally I conclud that, although small isolated areas have been in som respects highly fa ourabl for the production of n w pecies, yet that the course of modification will gen rally have been m re rapid n large areas and what is more important, that the new f rms produced on large areas, which already ha been victorious er many competitors, will be those that will spread most widely and will give rise to the greatest n mbe of new varieties and species. They will thus play a m re important part in the changin hist ry of th organi wo ld

In accordance w th this w w can, perhaps, und rstand som facts which will be again alluded to in our chapte on Geographical Distribution for instance the fact f the productions of the smalle continent of Australia w yielding bef re those of the larger Europæo-Asiatic area. Thus, also, t is th t continental productions hav everywh re become so largely naturalised on islands. On a small island the race for lif will have been less severe and th re will ha e been less modifica tion and less ext rmination. Hence we can und rstand h w t is that th flora of Mad ira, according t O wald Hee resembles to a ce tain extent th extinct tertiary flora of Europe. All fresh w t basins, taken togethe mak a small area compared with that of th sea or of the land. Consequ ntly th competition between fresh-w te prod ctions will hav been less severe than lsewhere new f rms will hav been then more slowly produced and old f rms m re slowl ext rminated. And t is in fresh wate basins that we find seven g n ra of Ganoid fishes, remnants of a once prepond rant order and in fresh wat w find som of the most anomalous form now kn wn in th world as th Ornithorhynchus and Lepidosiren which, like fossils, connect to certain extent ord rs at present widely sund red in the natural scal These anomalous f rm may be called living fossils th y ha endured to th present d y from ha in inhab ted a confined area, and from having been exposed to less varied, and therefore less severe, competition.

To sum p, as far as th extreme intricacy of the subject permits, th circumstances favourable and unf vourable for th reduction

of new species through natural selection I conclude that for terrestrial productions a large continental area which has undergone many oscillations of level will have been the most favourable for the production of many new forms of life fitted to endure for a long time and to spread widely Whilst the area existed as a continent the inhabitants will have been numerous in individuals and kinds and will have been subjected to severe competition When converted by subsidence into large separate islands there will still have existed many individuals of the same species on each island intercrossing on the confines of the range of each new species will have been checked after physical changes of any kind immigration will have been prevented so that new places in the polity of each island will have had to be filled up by the modification of the old inhabitants and time will have been allowed for the varieties in each to become well modified and perfected When by renewed elevation the islands were reconverted into a continental area there will again have been very severe competition the most favoured or improved varieties will have been enabled to spread there will have been much extinction of the less improved forms and the relative proportional numbers of the various inhabitants of the reunited continent will again have been changed and again there will have been a fair field for natural selection to improve still further the inhabitants and thus to produce new species

That natural selection generally acts with extreme slowness I fully admit. It can act only when there are places in the natural polity of a district which can be better occupied by the modification of some of its existing inhabitants The occurrence of such places will often depend on physical changes which generally take place very slowly and on the immigration of better adapted forms being prevented As some few of the old inhabitants become modified the mutual relations of others will often be disturbed and this will create new places ready to be filled up by better adapted forms, but all this will take place very slowly Although all the individuals of the same species differ in some slight degree from each other it would often be long before differences of the right nature in various parts of the organisation might occur The result would often be greatly retarded by free intercrossing Many will exclaim that these several causes are amply sufficient to neutralise the power of natural selection I do not believe so. But I do believe that natural selection will generally act very slowly only at long intervals of time and only on a few of the inhabitants of the same region I further believe that these slow intermittent results accord well with what geology tells us of the rate and manner at which the inhabitants of the world have changed

Slow though the process of selection may be if feeble man can do much by artificial selection I can see no limit to the amount of change to the beauty and complexity of the coadaptations between all organic beings one with another and with their physical conditions of life which may have been effected in the long course of time through nature s power of selection that is by the survival of the fittest

Extinction caused by Natural Selection

This subject will be more fully discussed in our chapter on Geology but it must here be alluded to from being intimately connected with natural selection Natural selection acts solely through the preservation of variations in some way advantageous which consequently endure Owing to the high geometrical rate of increase of all organic beings each area is already fully stocked with inhabitants and it follows from this that as the favoured forms increase in number so generally will the less favoured decrease and become rare. Rarity, as geology tells us, is the precursor to extinction. We can see that any form which is represented by few individuals will run a good chance of utter extinction during great fluctuations in the nature of the seasons or from a temporary increase in the number of its enemies But we may go further than this for as new forms are produced unless we admit that specific forms can go on indefinitely increasing in number many old forms must become extinct That the number of specific forms has not indefinitely increased geology plainly tells us and we shall presently attempt to show why it is that the number of species throughout the world has not become immeasurably great

We have seen that the species which are most numerous in individuals have the best

dominant species which offer the greatest number of recorded varieties. Hence, rare species

will be less quickly modified impro ed within any gi en period they will conseq ntly be beat n in the race f r life by th modified and impro ed d scendar ts f the comm n species.

From these se ral consid rat n I think it nent ll f llows, that as pec in tl

suff r most And w ha seen in th hapter the Strugl f r E ist ce th t it is tl e most losel ll ed f rms,—var t f the sam pec es, and pec es f the sam g n s r of related g ra,—wl l from l g nearly the same tru ture co stit t n, and hab ts, gen rall com int th se rest compet t n

kindred, and t nd t ext rmin t th m W see the sam process f t rmin t am gst ur domesticated prod t ns, thro gh th selectio of impro ed f rm by man Many curi ous instance o ld be g sl w l w quickly n breeds f ttle sheep and th animals, and n t f fl w rs, tak th place f ld r and inf rio k nds. I Y kshire t historically kn wn th t th an t black cattle re d placed by th l g h rns, and th t these re w pt y by th sl rt h rns (I quot tl w rd f n g ultu al w t) as if by som murd rou pest le ce

D r ge ge ce f Cl ar ter

Tl prin pl wl h I l de g ted by this t rm is f l gh mportance and plains, as I belie se ral mpo tant facts. In th first place, ar ties, tro gl m ked nes, thou h h g som h t f tl cl rac ter of spec es—as s w b th h peless d bts man ase l w to rank tl m—y t certainly d ff far l ss from ach th than d good and distinct peci s. N th less, according t my iew n t es are pec in the proce of format n, are as I l alled them icip t spec es H w tl doe the lesse l ff rence between ar t es becom augmer ted to th greate diff ce bet een species That this does hab t ally happe w m t inf from most f th inn m rabl species throughout nat re prese ting w ll marked dif rences wh reas ar ties, th supposed prototypes and pare ts of f ture w ll marked

spec es, present slight and ill-d fined d ffer ences. Mere chance as w may call it, m gl t ca se n a ty to d ffe in som ch racter from its p rents, and tl e off prin of th s var ty again to diffe from it parent in tl e very same charact r and in a greater d gree but th s al e would never accou t f r so hab tu l and larg a d gree of differe ce as t t twee tl spec f the same g nus

H ref rd cattl race and cart h rses, the se eral breeds of p geons, &c. could ne r h been effected by the m re cl ance accu mul t n f simil r variations during many success e ge rat ns. In pract ce a f n er is, f instance, truck by pigeon ha ing a slightly h rt beak anoth fanc r tru k by p geon h in a th r lo g r beak and n the ackn wledged prin ple th t fan r do not and will n t admire a med m tand ard but like tremes, they both go on (as has actually occ red w th th b-breeds of th t mble p geo) choos g and breed ng from b rd w th lo ger and l g beaks r w th sh rte and l o t beaks. Again w may suppose th t at n ea ly period f hi tory th m n f o nat n o d trict required swifte h rses, whilst tl se of an th r requ red strong r and b lki h rses. Th arly differences w uld be ry l ght b t, n th course f time from th co tin ed select n f swift horses in th case and of tro g on in th oth r th diff re ce w ld becom great and w ld b ted as f rming tw ub-breeds. Ultimat ly afte th lapse of ce tu es, th se ub-breed w ld becom con ted into two w ll-e tablished and d tin t breeds. As the d ff re ces becam gre t the inf r an mals with intermediat characters, being th w ft ry tro g w uld not ha e been sed f breeding and w ll thus ha tended to d sappe H re th we see in man prod cti ns the act n f what m be called th pri pl f d gence ca ing d f f rences, t first barely ppreciabl t ad ly to increase and th b eeds t di rg in ch ra t r both from each th and from their comm n pare t.

B t h w t m y b asked, can any anal g principl pply in nature I belie t can and doe pply most fficiently (though t was a long time bef re I saw how) from th simpl

circumstance that the more diversified the *descendants from any one species become in* structure constitution and habits by so much will they be better enabled to seize on many and widely diversified places in the polity of nature and so be enabled to increase in numbers

We can clearly discern this in the case of animals with simple habits Take the case of a carnivorous quadruped of which the number that can be supported in any country has long ago arrived at its full average If its natural power of increase be allowed to act it can succeed in increasing (the country not undergoing any change in conditions) only by its varying descendants seizing on places at present *occupied by other animals some of them for* instance being enabled to feed on new kinds of prey either dead *or alive some inhabiting* new stations climbing trees frequenting water and some perhaps becoming less carnivorous The more diversified in habits and structure the descendants of our carnivorous animals *become the more places they will be enabled* to occupy What applies to one animal will apply throughout all time to all animals—that is if they vary—for otherwise natural selection can effect nothing So it will be with *plants It has been experimentally proved* that if a plot of ground be sown with one species of grass and a similar plot be sown with several distinct genera of grasses a greater number of plants and a greater weight *of dry herbage can be raised in* the latter than in the former case The same has been found to hold good when one variety and several mixed varieties of wheat have been sown on equal spaces of ground Hence if any one species *of grass were to go on varying* and the varieties were continually selected which differed from each other in the same manner though in a very slight degree as do the distinct species and genera of grasses a greater number of individual plants of this species, including its modified descendants would succeed in living on the same piece of ground And we know that each species and each variety of grass is annually sowing almost countless seeds and is thus striving as it may be said to the utmost to increase in number Consequently in the course of many thousand generations the most *distinct varieties of any* one species of grass would have the best chance of succeeding and of increasing in numbers and thus of supplanting the less distinct varieties and varieties, when rendered very distinct from each other take the rank of species

The truth of the principle that the greatest amount of life can be supported by great diversification of structure is seen under many natural circumstances In an extremely small area especially if freely open to immigration and where the contest between individual and individual must be very severe we always find great diversity in its inhabitants For instance I found that a piece of turf three feet by four in size which had been exposed for many years to exactly the same conditions *supported twenty species of plants* and these belonged to eighteen genera and to eight orders which shows how much these *plants differed from each other So it is with* the plants and insects on small and uniform islets *also in small ponds of fresh water* Farmers find that they can raise most food by a rotation of plants belonging to the most different orders nature follows what may be called a simultaneous rotation Most of the *animals and plants which live close round any* small piece of ground could live on it (supposing its nature not to be in any way peculiar) and may be said to be striving to the utmost to live there but it is seen that where they come into the closest competition the advantages of diversification of structure with the accompanying differences of habit and constitution determine that the inhabitants which thus jostle each other most closely shall as a general rule belong to what we call different genera and orders

The same principle is seen in the naturalisation of plants through man s agency in foreign lands It might have been expected that the plants which would succeed in becoming naturalised in any land would generally have been closely allied to the indigenes for these are commonly *looked* at as specially created and adapted for their own country It might also perhaps have been expected that naturalised plants would have belonged to a few groups

in his great and admirable work that floras gain by naturalisation proportionally with the number of the native genera and species *far more in new genera than in new species* To give a single instance in the last edition of Dr Asa Gray s *Manual of the Flora of the Northern United States* 260 naturalized plants are enumerated and these belong to 162

genera. W thus see that these naturalised plants are of highly di rsified nature Th y differ moreo er t large t nt, from the indigenes, for out of the 16 naturalised gen ra, no less than 100 gen ra are not th re ind ous, and thus large proportional add tion is made to the genera n w livin in th United States.

B considering the nature of the plants o animals which ha in an country tru led successfully th th ind g nes and ha there become naturalised, w ma ga n som crud idea in hat manner som f the nat es would ha e to be modified, in rd to g in an advantage er their compatriots and we ma t least inf that di ersificat on f truc ture, amounting to new gen n diff rences, would be profitable to th m

The ad ants of di ersificatio of tru

Milne Edwards. N ph iologist d bts that a stomach adapted to d gest g tabl m tte alone, or flesh alo draw mo t n triment from these substances. So in th general economy of an land, th more wid l and perfect l the animals and plants are d rsified f different hab ts of lif so will greate umbe of indi iduals be capal le f there supporting themsel es. A set of animals, with th ir organisation b t little d rsified, could hardl compete w th set m re perfectl di rsified in structure It ma be d bted, for instance hethe the Australian marsupials, which are d ided into group differing b t littl from each the and feebl representing as M Waterhouse and oth rs ha remarked, our carni orous, ruminant, and rod t mammals, could successful compet w th these w llde ped rders. In th Au tralian mammals, see the process of di rsificatio in an earl and incomplete ta of dev lopment.

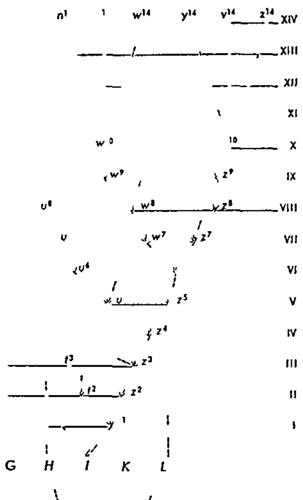
The Probabl Effects f th e Ac n of Natu al S l ction thro h D ergence of Cha acter nd Ext ct the De end nts f C mmo t cesto

After the foregoing iscussion, which has been much compressed, w ma assum that the modified escendant of an on pecies ill succeed so much the bette as th be come more d rsified tructure and are thus enabled t encroach on places occupied by oth beings. Now l t us see h w this prin iple of ben fit being d ri ed from d rgence of character combined with the principles of natural selection and of extinction, tends to act.

Th accompanying diagram will aid us in und rstanding this rath perpl xin bject Let A to *L* represent th species of a g nus large in ts wn country thes species are pposed to resembl each th r in unequal d grees, as is so ge rally th case in nature, and as is represented in th diagram by the l tt rs tandi g t unequal distances. I ha said a larg g n s, because as we saw in the second chapt an a rage more species vary in large gen ra than in mall genera and the varyin spec s f the large genera present a greate numbe f vari ties. We have, also, seen that th species, which are the common est and th most wid ly diffused, vary m re than d th rare and restricted species. Let (A) be a common, wid l diffused and vary in speci s, belongin to a g nus large in its wn country Th branchin and d rgin d tted lines of unequal l ngths proceedin from (A) ma represe t ts arying off-pring. Th riations are supposed t be xtrem ly slight, b t of th most d rsified nature the are t supposed all to ppear imultaneously b t often aft l ng int r als of time no are

lected. And here th importance of the prin ciple of ben fit deri ed from di erg nce f character comes in f this will gen rally le d to the most diff rent o di rgent riation (represented b th o t d tted line) bein preserved and accumulated by natural selection. When a d tted lin reaches o of th horizo tal lines, and is there m ked by mall umbered l tter a sufficient amount of aria tion is supposed t ha been accumulated to f rm t into fairl w ll m ked variety such as w uld be thought w rth of record in st matic wo k.

Th int r als between th horizontal lines in th diagram m represent each a thousand m re gen rations. Afte a thousand gen ra tions, spec es (A) is supposed to ha produced tw fairl well-marked varieties, namely and m These two arieties will gen rally still be posed to th sam conditions which mad their parents ariable and th tend ncy to ariabilit is in tself h reditary consequ ently the will likewise tend to ary and



A B C D E F
G H I K L
XIV XIII XII XI X IX VIII VII VI V IV III II I

commonly in nearly the same mann r as did their parents. Moreo these two varieties, bein onl slightl modified forms, will tend to inherit those ad antages which made th ir parent (A) more numerous than most of the other inhab itants of the same country they ill also partake of those more general advantages which mad th genus to which the parent-species belonged, a large genus in its wn country And al these circumstances are favourable to the production of new varieties.

If, then, these two arieties be variable, the most divergent of their variations will generally be preserved d ring the next thousand generations. And after this interval, variety is supposed in the diagram to ha e produced variety which will, wing to th principl of divergence, differ more from (A) than did variet Variet m is supposed to ha produced tw arieties, namel m and s diff r ing from each other and more considerabl from their common parent (A) We may con tinue the process by similar steps f any length of tim som of the vari ties, after each thousand gen rations, producing only a single variet b t in more and more modified condition, som producing two r three arieties, and som failin to produce any Thus the arieties or modified descendants of the common parent (A) will generally go on increasing in number and d rging in charac ter In the diagram the process is represented up to the ten thousandth generation, and un der cond nsed and simplified f rm p to the fourteen-thousandth generation.

B t I must here remark that I do not suppose that the process oes on so regularly as is represented in th diagram, though in t self made somewhat irregular nor that t goes on continuousl t is far more probable that each form remains for long periods unaltered, and then agai und rgoes modification. Nor do I suppose that the most divergent varieties are in ariably preserved medi m f rm may often long endure, and may or may not produce more than on modified descendant for natural selection will alw act accordin to the nature of the places which are either unoccupied or not perfectly occupied b other beings and this will depend on infinit ly complex relations. B t as general rule th more di ersified in structure th descendants from any one pecies can be rendered, the more places the ill be enabled to seize on, and the more their modified progeny will increase. In our diagram the line of succession is broken at regular intervals by small numbered lett rs marking th successive forms which have become sufficiently distinct to be recorded as varieties. B t these breaks are imaginary and might hav been inserted anywhere, after inter vals lon enou h to allow th accumulation of a consid rable amount of di ergent variation.

As all the modified descendants from a common and widely-diffused species, belo ing to a large gen s, will tend to partake of th same ad an ful in l in nu...

this is represented in the diagram by the several divergent branches proceeding from (A) The modified offsprin from th later and more highly improved branches in th lines of descent, will, t is probable often take the place of, and so destroy the earlier and less impro ed branches this is represented in the diagram by som of the lower branches not reaching to th upper horizontal lines. In some cases no doubt th process of modification will be confined to a single line of descent and the numbe of modified descendants will not be increased although th amount of diverg ent modification may have been augmented. This case would be represented in the diagram, if all the lines proceeding from (A) were removed, excepting that from a to a^{10} In the sam way the English race-horse and English pointer ha e pparently both gone on slowly d rging in characte from their original stocks, without the having given off any fresh branches or races.

After ten thousand gen rations species (A) is supposed to ha produced three forms, a^{10} f^{10} and m^{10} which, from having diverged in character during the successive generations, will have com to differ largely but perhaps unequally from each other and from their common parent. If w suppose the amount of change between each horizontal line in our diagram to be excessively mall, these three forms may still be only well-marked varieties b t w have only to suppose the teps in th process of modification to be more num rous or greater in amount, to convert these three forms into well-defined or at least into d bt ful species. Thus the diagram illustrates th teps by which th mall differences distinguishing varieties are increased into the larg dif rences distinguishing pecies. By continuing the sam process f a great r numbe of generations (as shown in the diagram in a cond nsed and simplified manner)

we get eight pecies marked by the letters be tween a^{14} and m^{14} all descended from (*A*) Thus as I believe *species are multiplied and* genera are formed

In a large genus it is probable that more than one species would vary In the diagram I have assumed that a second pecies (*I*) has produced by analogous steps after ten thou sand generations either two well marked varieties (w^{10} and z^{10}) or two species according to the amount of change supposed to be represented between the horizontal lines After fourteen thousand generations six new pecies marked *by the letters* n^{14} to z^{14} are supposed to have been produced In any genus the species which are already very different in *character from each other will generally tend* to produce the greatest number of modified descendants for these will have the best chance of seizing on new and widely different places in the polity of nature hence in the dia gram I have chosen the extreme species (*A*) and the nearly extreme species (*I*) as those which have largely varied and have given rise to new varieties and species The other nine species (marked by capital letters) of our 1

pru p co ...... y ...

played an important part As in each fully stocked country natural selection necessarily acts *by the selected form having some advan* tage in the struggle for life over other forms, there will be a constant tendency in the im proved descendants of any one species to sup- plant and exterminate in each stage of descent their predecessors and their original progeni

lated to each other in habits constitution and structure Hence all the intermediate forms between the earlier and later states that is between the less and more improved states of the same species, as well *as the original parent* pecies itself will generally tend to become extinct. So it probably will be with many whole *collateral lines of descent* which will be conquered by later and improved lines If however the modified off pring *of a species* get into some distinct country or become quickly adapted to some quite new station in which off pring and progenitor do not come into competition both may continue to exist

If then our diagram be assumed to repre- sent a consi lerable amount of modification species (*A*) and all the earlier varieties will have *become extinct being replaced by* eight new pecies (a^{14} to m^{14}) and pecies (*I*) will be replaced by six (n^{14} to z^{14}) new pecies

But we may go further than this The origi nal species of our genus were supposed to resemble each other in unequal degrees, as is so generally the case in nature pecie (*A*) being more nearly related to *B C* and *D* than to the other species and pecies (*I*) more to *G H K L* than to the others These two species (*A*) and (*I*) were also supposed to be *very common and widely diffused pecies, so* that they must originally have had some ad vantage over most of the other specie of the genus Their modified descendants, fourteen in number at the fourteen thousandth genera tion will probably have inherited some of the same advantages they have also been modi fied and improved in a diversified manner at each stage of descent so as to have become adapted to many related places in the natural economy of their country It seems therefore *extremely probable that they* will have taken the places of and thus exterminated not only their parents (*A*) and (*I*) but likewise some of the original pecies which were most nearly related to their parents. Hence very few of the original *species* will have transmitted off spring to the fourteen thousandth generation We may suppo e that only one (*F*) of the two pecies (*E and F*) which were least closely related to the other nine original pecie has transmitted descendants to this late sta e of descent.

The new species in our diagram descended *from the original eleven pecies will now be* fifteen in number Owing to the divergent tendency of natural selection the extreme amount of difference in character between species a^{14} and will be much greater than that between the most distinct of the original eleven pecies The new pecies moreover will be allied to each other in a widely different *manner Of the eight descendants from* (*A*) the three marked *a q p* will be nearly

distinct from the three fr t nai ed pec and lastly *o e* and *m* ill l e n arly re lated one to the other but, fr m l aving

IV

di rged t the first commencem t f the process of modificati n, will be w d ly d ff rent from the oth fi pec es, and m constit t sub-gen disti t g us.

Th ix d sce dants from (*I*) w ll f rm two sub-g ra r g n ra. B t as th riginal pecies (*I*) diff red larg ly from (*A*) tand g early t th treme d f the ori inal gen s, the six d sce dants from (*I*) will own to inheritance alo d ff cons derabl from the ight d sce dants from (*A*) th tw gro ps, m reo e are supposed t h g di rg g diff re t directions. Th int r m l t spec es, also (and this is ry m

g ra, as d ti t sub-f mil s

Thus t is, as I bel e th t tw m re g ra are prod ced b d sce t w th modifi cation, from tw m re pec s f tl sam g us. And th tw n re pare t pec are supposed t b d scended from som o pe- ie of an arli g s. In d ag am th is indi ted by th brok li s, be tl th p tal l tt rs, co gi g in b-bra h d wn ards toward l point th point represe t a peci s, th pposed prog t f se al w b-g ra and g a.

It is rth whil t reflect f m m t n th haract f th w pec *F* wl h pposed t t h d rged m h in l r act b t t ha ret ed th f rm f (*F*) th nalt red lt red ly l ght l ree I tl is case ts affinit t th th f rt e w pec ll be f curi and re t t re B ing desce ded from form hicl tood bet een th pare t pec (*A*) and (*I*) w j posed to be tin t and nkn w t ll be som d gree t rm diat laract bet ee th t gro p d scend l from th se t pec s. B t as th se t gro ps h g l gi g harac t from th t pe f th pare ts, th n w speci (*F*) ll t be d rectl t rmed t bet een th m b t rath bet ee t pes f th tw gr p an l rv t ah t w ll b able t all l ase bef re h m d

I th diagram each l rizo tal lin has hith rt bee pposed t represe t th u sand ge ratio s, b t ach m y represent a million or more g ratio t may also represent sectio f tl ccessi trata f the artl s cru t in luding extinct remains \ wh n w com to our ch pte on (

m u

and w can nd rstand this fact to tn t n t pec s li ed at various remote pocl wh n th branch g line of desce t had d rged l ss.

I see n reason t l m t th process f mod ficat on as n w xplained to th f rm t n of g ra al If in the d agram w ppose th amo nt f chan represented b e h cee ro p f d rri g d tted li s t be gi mark

m

d rs, ccordin to th mount f d gent mod fic ti supposed t be represented in th d gram And th tw n w f mil s, o ord rs, re d sce ded from two pec s f th gi al g nus, and th se are pposed to b d sce ded from som till m re an nt d unkn n f m.

W ha seen th t in ach country it the pec s b l gi g t th l rg g n ra h ch oft est present n ti m p nt spec This, deed m ght h been xpected f as n t al selecti n acts thro gh e f rm h g som ad antag e th f rm in tl trugg l f xist nce t w ll chi fly t n th se which already h som ad antage and th larg ness f any gro p sh w th t t peci l inh rited from comm n ances- t som ad antag in comm n. H ce th trugg l f th prod ti n of n w and modi fied descendants will mainl h between th larg gro p which are all tryi g to incre n mbe O larg group w ll l ly co i an th larg gro p red ce ts numbers, and th l sse ts hance of f th ari ti n and impro m nt. W thin th sam l rg gro p tl lat and m re h gl ly pe fected t gro ps, from branch g t and seizing n m y ew place th pol ty f Nature will constantl t d t supplant and destroy the arli and l ss impro ed sub-gro ps. Small and brok n gro ps and sub-gro ps will finally

disappear Looking to the future we can predict that the groups of organic beings which *are now large and triumphant* and which are least broken up that is which have as yet suffered least extinction will for a long period continue to increase But which groups will ultimately prevail no man can predict for we know that many groups formerly most extensively developed have now become extinct Looking still more remotely to the future we may predict that owing to the continued and steady increase of the larger groups a multitude of *smaller groups will become utterly* extinct and leave no modified descendants and consequently that of the species living at any one period extremely *few* will transmit descendants to a remote futurity I shall have to return to this subject in the chapter on Classification but I may add that as according to this view extremely few of the more ancient species have transmitted descendants to the present day and as all the descendants of the same species form a class we can understand how it is that there exist so few classes in each main division of the animal and vegetable kingdoms Although few of the most ancient species have left modified descendants yet at remote geological periods the earth may have been almost as well peopled with species of many genera, families orders and classes as at the present time

On the Degree to which Organisation tends to advance

Natural Selection acts exclusively by the preservation and accumulation of variations which are beneficial under the organic and inorganic conditions to which each creature is exposed at all periods of life The ultimate result is that each creature tends to become more and more improved in relation to its conditions This improvement inevitably leads to the gradual advancement of the organisation *of the greater number of living beings*

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the vertebrata the degree of intellect and an approach in structure to man clearly come into play It might be thought that the amount of change which the various parts and organs pass through in their development from the embryo to maturity would suffice as a standard of comparison but there are cases as with certain parasitic crustaceans, in which several parts of the structure become less perfect so that the mature animal cannot be called higher than its larva Von Baer s standard seems the most widely applicable and the best, namely the amount of differentiation of the parts of the same organic being in the adult state as I should be inclined to add and their specialisation for different function or as Milne Edwards would express it the completeness of the division of physiological labour But we shall see how obscure this subject is if we look for instance to fishes amongst which *some naturalists rank those as highest which* like the sharks approach nearest to amphibians whilst other naturalists rank the common *bony or teleostean fishes as the highest inas*much as they are most strictly fish like and differ most from the other vertebrate classes We see still more plainly the obscurity of the subject by turning to plants amongst which the standard of intellect is of course quite excluded and here some botanists rank those plants as highest which have every organ as sepal petals stamens and pistils fully developed in each flower whereas other botanists probably with more truth look at the plants which have their several organs much modified and reduced in number as the highest

If we take as the standard of high organisation the amount of differentiation and specialisation of the several organs in each being when adult (and this will include the advancement of the brain for intellectual purposes) natural selection clearly leads towards this standard for all physiologists admit that the specialisation of organs inasmuch as in this state they perform their functions better is an advantage to each being and hence the accumulation of variations tending towards specialisation is within the scope of natural selection On the other hand we can see bearing in mind that all organic beings are striving to increase at a high ratio and to seize on every *unoccupied or less well occupied place* in the economy of nature that it is quite possible for natural selection gradually to fit a being to a situation in which several organs would be superfluous or useless in such cases there would be retrogression in the scale of organisation Whether organisation on the whole has actually advanced from the remotest geological periods to the present day will be more conveniently discussed in our chapter on Geological Succession

But it may be objected *that if all organic* beings thus tend to rise in the scale how is it

IT t t th w ld m lt tude f th that low cad l more ... planted and ext rmin ted th l w Lan rck, ho belie ed in an nnat and in vitabl tend ncy t ard perfection all rgan beings, seems t l f lt th difficult so strongl that he was led t ppose that n w and simpl f rms re co tinually being produced b spo taneou g n ration Sc e ce has not as y t pro ed th truth of this beli f ... th f t re m re eal On ur

... sarily includ progressi d l pm t—t nly tak ta of such ar tio as arise and are be ficial t ach re t re nder its comple relat ns of life And t may be asked hat ad tag far as w can see ould t be to an inf sorian an m lcul —t an intestinal rm—o t an arth w rm to be highl ganised If t u re n ad antag these f rms would be left, by nat ral selecti n, unimpro ed b t l ttl mpro ed, and m l t remain for ind finit ag t th ir prese t lo l condi tio And geolog t lls that som of the lowest forms, as th nf sori and rhizopods, ha remain d f an norm period in arl th prese t t t B t to suppose that most f th many tin low f m ha ot th l t ad anced si ce the first da n f l f would be extrem ly rash for ... t ral t wh l as l sected som of th bei g now ra ked ... lo th sc l m t ha bee truck w th th really wondro and bea t f l rganisat n.

N arl th sam remarks are pplic ble f look t the d ff rent grad of org nisati n th th sam gre t gro p f n tance in the rt brata, t the co-exi t nce f m mmal and fish—am t mammalia, t the co-exi t nce of man and th rn tho hync us—mon t fishe to the co-exist nce of th shark and th lancelet (Amphi) wh h latter fish in the extreme simplicit of t truct re pproaches the in rtebrat classes. B t mammals a d fish hardly com into competition with eac othe th ad ancement f the hole class of mammals, o of certain members in this las to th highest grad ould not lead to their taking the place of fishes. Physiol gists b lie that th brain must be bathed by warm blood to be highl acti e and this req re aerial re p ratio so th t warm blooded mammal when nhabiti g the w t l e und r a disad antag n ha ing t come co tin ally t th urface to bre th W th fishes, m mber f the shark famil would ot te d t pplant th lancelet f r th lancel t, as I hea from Fritz Muller has as sol companion and comp t t on th e l ar ren sand sl re f South Braz l, an an mal us ann l d Th three lowest rs f mammals, nam ly mars pials, ed ntata, and rodents, co-exi t in South America in the sam reg n w th numero s m nk s, and probably t r f re l ttl w th ach oth Alth gh ganisa t n, on th whol m ha ad nced and be t ll ad ancing th ro gho t the w ld t th scal will always prese t many d gree of per fect f th h gh ad ancement of ce tain wh le cl ss , r of erta m mb f e ch lass, doe n t at all nece sari l ad to the exti t on of those group w th which th d n t nt nt cl se compet t In som cases, ... w h ll l reaft see l wl ganised f rms

... us, ... se re competiti n and wh re th eir scanty n mbers ha ret rded the chance f f ur bl ar ti ns arising.

Finall I belie that many lowly rganised f rms n ist thro gh t th w ld from ari us causes. In some case ari ti ns in i dual diff rence f f urabl nature ma ha risen f natural select n to act n and accumulate In n ase probably has time fficed f th utm t poss bl am t f d l pm t. In som few cases th re has been what w mu t call retro ress n f organisat n. B t th mai cause l n the ...

... rgani beings we ma b l e presented th mplest t ture h t has bee asked co ld th first t p the ad ancem nt d ff re t ti f part ha arise M Herbert Spe ce ld prol abl answ that, as soon as si pl unicellular rganism cam by growth o d si t be compo nded f several cells, becam ttach d to any s pport ing surface, l law that hom log us units of any rd become d ff re tiated in proportion as their relations to incid t f rces become

different would come into action But as we have no facts to guide us speculation on the subject is almost useless It is however an *error to suppose that there would be no struggle for existence* and consequently no natural selection until many forms had been produced variations in a single species inhabiting an isolated station might be beneficial and thus the whole mass of individuals might be modified or two distinct forms might arise *But, as I remarked towards the close of the* Introduction no one ought to feel surprise at much remaining as yet unexplained on the origin of species if we make due allowance for our profound ignorance on the mutual relations of the inhabitants of the world at the present time and still more so during past ages

Convergence of Character

Mr H C Watson thinks that I have overrated the importance of divergence of character (in which however he apparently believes) and that convergence as it may be called has likewise played a part If two species belonging to two distinct though allied genera had both produced a large number of new and divergent forms it is conceivable that these might approach each other so closely that they would have all to be classed under the same

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bute to convergence a close and general similarity of structure in the modified descendants *of widely distinct forms The shape of a crystal* is determined solely by the molecular forces and it is not surprising that dissimilar substances should sometimes assume the same form but with organic beings we should bear in mind that the form of each depends on an infinitude of complex relations namely on the variations which have arisen these being due to causes far too intricate to be followed out — on the nature of the variations which have been preserved or selected and this depends on the surrounding physical *conditions and* in a still higher degree on the surrounding organisms with which each being has come into competition —and lastly on inheritance (in itself a fluctuating element) from innumerable progenitors all of which have had their forms determined through equally complex *relations It is* incredible that the descendants of two organisms which had originally differed in a marked manner should ever afterwards

converge so closely as to lead to a near approach to identity throughout their whole organisation If this had occurred we should meet with the same form independently of genetic connection recurring in widely separated geological formations and the balance of evidence is opposed to any such an admission

Mr Watson has also objected that the continued action of natural selection together with divergence of character would tend to *make an indefinite number of specific forms.* As far as mere inorganic conditions are concerned it seems probable that a sufficient number of species would soon become adapted to all considerable diversities of heat moisture &c but I fully admit that the mutual relations of organic beings are more important *and as the number of species in any country* goes on increasing the organic conditions of life must become more and more complex Consequently there seems at first sight no limit to the amount of profitable diversification of structure and therefore no limit to the number of species which might be produced We do not know that even the most prolific area is fully stocked with specific forms at the Cape of Good Hope and in Australia which support such an astonishing number of species many European plants have become naturalised But geology shows us that from an early part of the tertiary period the number of species of shells and that from the middle part of this same period the number of mammals has not greatly or at all increased What then checks an indefinite increase in the number of species? *The amount of life (I do not* mean the number of specific forms) supported on an area must have a limit depending so largely as it does on physical conditions therefore if an area be inhabited by very many species each or nearly each species will be represented by few individuals and such species will be liable to extermination from accidental fluctuations in the nature of the seasons or in the number of their enemies The process of extermination in such cases *would be rapid whereas the production of* new species must always be slow Imagine the extreme case of as many species as individuals in England and the first severe winter or very dry summer would exterminate thousands on thousands of species Rare species and each species will become rare if the number of species in any country becomes indefinitely increased will on the principle often explained present within a given period few favourable

variations conseq tly the process f g g birth t w specifi f rm wo ld tl u be re tarded Wh any pec s becom s ry r re lose interbreeding w ll h lp t xt rminate t a th h e th ught that th s com s into play in acco t g f the deteri at on of tl e Scot

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po t lem t d min t pec wh ch l

tl y w ll t d to s pplant and t min t

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Summary of Cl apter

If und chang g co d t f lif g being prese t d dual d ff re ce alm t ry part f tl tru t re and th ann t be d sp ted if tl b ow g to the geo-

gan being t acl th and to th con ditio f lif ca g an f t d ty in truct re co t t t and l abits, t b ad antageo t tl m t ld b m t tra rdinary fact f n t l d occ red usef l to ach be g n lfare th sam man as so m y nat h occ ed sef l t man B t f n t sef l t any gan bei g d occ ass redly d d ls th haract sed w ll h th best chai ce f be g preserved th truggl f lif d from tl t g pri cipl f nh nt ance tl se ll t d t prod ce ff pri g m ilarly charact rised Tl is pri] l f prese ation, tl r l f th fittest, I l called N t al Select It l ad t tl m pro m t of ach re t re rel t to ts organic and in rganic co d t f lif and

consequ ntly in m st cases to what mu t be l d dva ce in rganisat n N r

t b g h t d at corre po d g ages c n mod fy the gg seed r young as asily as tl ad lt Am g t many animals, sexual s l c t n w ll h v giv n ts aid t rdinary sel c t by ass ring to th m st gorou and be t ad pted m l s tl great st numbe of off n g Sexu l lect n w ll lso gi ch ac

Wh th n t l select n has really thu acted n dapting th r s f rms f lif t the se e l co d t s and stat o must b judged by th g e l t o a d balan e f dence g n in th foll wing chapter But w h e l eady seen h w t ta ls extinct n a d h w l g ly t ct n has acted in the w ll s l st y geology plainly declare N t r l lect als l ds to d v rg ce f ch act f th more gan c be g d ge in tru ture hab ts nd nstitut o by so

d to tl prod ct n t ral sed in f re gn l d Th ref c d n g the mod ficat n f th d sce dants f y spec and d g tl i ant t ggle f all pec to i crease numb s, th more d fied the descend ants becom the b tte w ll b the r ch nce f ccess th b ttl f l f Thu th m ll d ff re ce d t gu h g an ti f th me pec t ad ly t d t in as t ll they eq l tl gr te d ffe c ce b tw n p c es f the m g f d t inct gene W h seen th t t the common the w d ly-d ff ed and w d ly rang g spec s b l g g to th larg r g n a w th n ach class wh ch ary m t and these t d t transm t t th modified ffsp g th t p n ty wh ch n w m k tl m dominant n th w co tri N t l select as has ju t been remarked l ad to d g ce f h ract nd to m ch tin ti f tl l ss mpro ed d int rmediat f rms of l f On th se prin pl s, tl n t re f th ffi t d the g rally w ll-d fi ed distin t s be t een th m bl gani beings n h class thro gh t th w ld m y be explai ed

It is a truly wonderful fact—the wonder of which we are apt to overlook from familiarity—that all animals and all plants throughout all time and space should be related to each other in groups subordinate to groups in the manner which we everywhere behold—namely varieties of the same species most closely related species of the same genus less closely and unequally related forming sections and orders sub classes and classes The several subordinate groups in any class cannot be ranked in a single file but seem clustered round points and these round other points and so on in almost endless cycles If species had been independently created no explanation would have been possible of this kind of classification but it is explained through inheritance and the complex action of natural selection entailing extinction and divergence of character as we have seen illustrated in the diagram

The affinities of all the beings of the same class have sometimes been represented by a great tree I believe this simile largely speaks the truth The green and budding twig may represent existing species and those produced during former years may represent the long succession of extinct species At each period of growth all the growing twigs have tried to branch out on all sides, and to overtop and kill the surrounding twigs and branches in the same manner as species and groups of species have at all times overmastered other species in the great battle for life The limbs divided into great branches, and these into lesser and lesser branches were themselves once when the tree was young budding twigs, and this connection of the former and present buds by ramifying branches may well represent the classification of all extinct and living species in groups subordinate to groups Of the many twigs which flourished when the tree was a mere bush only two or three now grown into great branches yet survive and bear the other branches so with the species which lived during long past geological periods very few have left living and modified descendants From the first growth of the tree many a limb and branch has decayed and dropped off and these fallen branches of various size may represent those whole orders families, and genera which have now no living representatives and which are known to us only in a fossil state As we here and there see a thin straggling branch springing from a fork low down in a tree and which by some chance has been favoured and is still alive on its summit so we occasionally see an animal like the Ornithorhynchus or Lepidosiren which in some small degree connects by its affinities two large branches of life and which has apparently been saved from fatal competition by having inhabited a protected station As buds give rise by growth to fresh buds and these if vigorous branch out and overtop on all sides many a feebler branch so by generation I believe it has been with the great Tree of Life which fills with its dead and broken branches the crust of the earth and covers the surface with its everbranching and beautiful ramifications

CHAPTER V

LAWS OF VARIATION

I ha e hith rto som times poken as if the var atio —so comm and mult f rm with ganic beings de d mest cat nd in a lesse degree with th se und r n ture—were d to hance This, f co rse is h lly in correct mpres ion, b t it serves to acknow

cr ki par

and mo trosit occ rri g m h m re fre q entl nd d m t cat n than u de na ture nd th gre t ariab lit f peci ha ing id rang s than f th se w tl restri ted ranges, lead to tl concl that riab l ty is g rall related to tl e co d tions f lif t hicl ach peci has bee posed d ring sev ral ccess g n r t ns. In th first hapt I tt mpted to sl w th t changed cond tions act in t w ys, d rectly th hole ganisat o certai parts l and nd rectl thro gh tl reprod ti s t m. I all ases th re are t fact rs, tl a t re of tl rg ni m, wh ch m cl tl most mportant of tl two, and tl t f tl cond tions. Tl d rect acti f changed co l tions lead t d fi t nd fi t res lts. In the latt case tl ganisat seem t be com plastic and w h m ch fl t t g ariab l t I th f rm case tl t re of th gan m cl th t t ll readil en bjected t certa co d t s, and all, n arl all tl nd d als becom modif ed th sam

It is ry d fficult t decid l w f chang d ond tions, uc] as of l m t food we h acted d fi t man Tl ere reaso t beli that tl co rse f t m th ffects h bee gre t than ca be pro d l y cl ar ev l nce B t w m saf l co l d tl t tl m ral l ompl co-ad j t t ns f tru t re hich w see thr gh t t re bet ee arious rganic beings, annot be ttrib ted simpl t ucl action. I th f ll wing cases th cond tion seem t ha prod ced som slight d fi t ffect L F rbe asserts that sl lls at their so th rn lim t, and hen li ing shallow te are m re brightly coloured than those of the sam species from further n rtl r from a greate d pth but th s cer tainl doe not alw ys h ld good Mr Go ld b l s th t birds f tl s me species are m re brightly col ured u der a l ar atmosphe er than wh li ing n ar th coast o on islands, and W llaston convinced th t res dence n ar the sea affect the col u of insects. Moquin Tand n g es a li t f plants wh l wh n growing n ar the sea hore h tl ir le ve in som d gree fleshy th ugh n t lsewhere fleshy These l ghtl arying organisms are int resti in as far as th y present cl aract rs l t th se possessed by the spec

any being

b t t th accum l t e acti n f natural select on, and l w m l t th u first act n f th co d ti ns of l fe. Thus, it is well kn wn

d d l h ing been fa oured and preserved l ri g man g n rat ns, and h w m ch to

Instances co ld be g n f milar ari t b in prod ced from tl e sam pec es und te nal co d t f lif as d ff re t as can w ll be co ce d nd n tl th hand f d ssim lar iet es b ing produ ed unde p pare tly th sam t rnal co d t ns A ain nn me al l nstances re kn wn to e e v n t ralist, of peci keep g tru o t vary g t all, altl gl l g d th m t p po te lim t s. S ch co de ti ns as th se m h m to lay less w ght the direct a tio f tl surr nd g co d t s, than n a tend y t ary d t causes f whi l w are q te g ant

In se se th co d t is of lif m y be said t l to cause ariab lity the di rectl nd rectly b t l k w se to incl d nat ral select n, f th co d t ns d termin wh th this that ari ty shall rvi e B t wh n man is th selecting g t we clea ly ee that th two lements f change are distin t

variability is in some manner excited but it is the will of man which accumulates the varia tions in certain directions and it is this latter agency which answers to the survival of the fittest under nature

Effects of the increased Use and Disuse of Parts as controlled by Natural Selection

From the facts alluded to in the first chap ter I think there can be no doubt that use in our domestic animals has strengthened and enlarged certain parts and disuse diminished them and that such modifications are inher ited Under free nature we have no standard of comparison by which to judge of the ef fects of long-continued use or disuse for we know not the parent forms but many animals possess structures which can be best explained by the effects of disuse As Professor Owen has remarked there is no greater anomaly in na ture than a bird that cannot fly yet there are several in this state The logger headed duck of South America can only flap along the sur face of the water and has its wings in nearly the same condition as the domestic Aylesbury duck it is a remarkable fact that the young birds according to Mr Cunningham can fly while the adults have lost this power As the

flight

t the

now

inhabiting or which lately inhabited several oceanic islands tenanted by no beast of prey has been caused by disuse The ostrich indeed inhabits continents and is exposed to h

that the progenitor of the ostrich genus had habits like those of the bustard and that as the size and weight of its body were increased during successive generations its legs were used more and its wings less until they be came incapable of flight

Kirby has remarked (and I have observed the same fact) that the anterior tarsi or feet, of many male dung feeding beetles are often broken off he examined seventeen specimens in his own collection and not one had even a relic left In the *Onites apelles* the tarsi are so habitually lost, that the insect has been de scribed as not having them In some other gen era they are present but in a rudimentary con dition In the Ateuchus or sacred beetle of the Egyptians, they are totally deficient. The evi dence that accidental mutilations can be in

t ... should make us cautious in denying this tendency Hence it will perhaps be safest to look at the entire absence of the anterior tarsi in Ateuchus and their rudimentary condition in some other genera not as cases of inherited mutilations but as due to the effects of long continued disuse for as many dung feeding beetles are generally found with their tarsi lost this must happen early in life therefore the tarsi cannot be of much importance or be much used by these insects

In some cases we might easily put down to disuse modifications of structure which are wholly or mainly due to natural selection Mr Wollaston has discovered the remarkable fact that 200 beetles out of the 5 0 species (but more are now known) inhabiting Mad eira are so far deficient in wings that they can not fly and that of the twenty nine endemic genera no less than twenty three have all their species in this condition! Several facts — namely that beetles in many parts of the world are frequently blown to sea and perish that the beetles in Madeira as observed by Mr Wollaston lie much concealed until the wind lulls and the sun shines that the propor tion of wingless beetles is larger on the exposed Desertas than in Madeira itself and especially the extraordinary fact so strongly insisted on by Mr Wollaston that certain large groups of beetles elsewhere excessively numerous which absolutely require the use of their wings are here almost entirely absent —these several considerations make me believe that the wing less condition of so many Madeira beetles is mainly due to the action of natural selection combined probably with disuse For during many successive generations each individual beetle which flew least either from its wings having been ever so little less perfectly de veloped or from indolent habit will have had

being

those

would

... sea and thus de stroyed

The insects in Madeira which are not ground feeders and which as certain flower feeding coleoptera and lepidoptera, must habitually use their wings to gain their subsistence have as Mr Wollaston suspects their wings not at all reduced but even enlarged This is quite compatible with the action of natural selec

tion. For when a n w insect first arr ed on the island, the tendency of tural selecti n to n large or to reduce th wi gs, wo ld d pend on hethe a great r number f ind d als w re sa ed by successfully battling w th the winds, I rri un the tt mpt and rarely n r

urtue t, as the bad swimm rs if th y had n t been able to swim at all and had t ck to th wreck.

The es of moles and of som b rrowi g ro- dents are rudimentary n iz and in som cases are quite co ered b skin and f This stat of the es is probably d to gradual re- ductio from disuse b t aided pe haps by natural selectio I So th Am ri a, a b rrow g rod t, th t cot co o Ct om s, s e en

as es are certainly n t ecessary to an mals havi g s bterran an hab ts, a red t in thei size, with the adhes of th lids and gro th of fur th m, m ght in ch case be an ad antag and if so nat ral select would aid the ffects of d suse

It is w ll known th t se ral animals, be- longing to th most d ff re t lasses, wh h in hab t the ca of Carn la and f K t cky are blind I som of th crabs th foot talk f th remai s, tho gh th is g — the tand f th t lescope th re th gh th telescope w th ts glasses has bee lost. As t is difficult t magine that es, tho gh useless, co ld be an w jurio to animals li ng darkness, their loss ma be ttrib ted to disuse I one of th blind mals, nam l the ca rat (Neotoma) two of wh h w re cap t red b Professo Sill man t bo half m le listance from th mo th f tl ca and therefore not th prof undest d pths, tl es w re lustrous and of larg size and these an mals, as I am nf rmed b Professo S lli- man, aft ha ing bee posed f abo t month to graduated light, acquired dim perception of objects.

It is difficult to magi cond tions of lif more similar than deep limesto ca erns u der nearly similar climate so that, in ac- cordance with th old view f the blind ani mals h ving been separatel created f r the Am rican and European caverns, ery close similarity in th ir organisati n and affiniti s i h hee expected This is certainly

f w f rms between the Mammoth ca (in K t cky) and the ca in Carn la, other wise than as a ry plain xpression of that analogy wh ch bsists g rally between the fauna f Europe and of North Am rica. On my v w we must ppose that American ani mals, ha ing in most cases ordinary powers of vi slowl m grated b ccessi g nera tio from the t n ld t th deepe and deeper recesse f the Kent cky ca es, as did European animals to th a s of Europe. W ha e som d nce f this grad ti n of hab t fo as Schiodte remarks, W accord ingl look pon the bt rran an f nas as mall ram fications wh ch ha pen trated in to the arth from the geograph call l m ted f nas f th adj cent tracts, and which as th y t ded th msel into darkness, h been accommod ted to u rounding circum tances. Animals n t far remot from rdinary f ms, prepare the trans ti from light t d kn ss. N t f ll w tl se that are co tru t ed f tw l ght and last f all those d tined f t tal darkn ss, and wh se f rmation quit peculiar Tl ese remarks f Schiodt t sh ld be und rstood, ppl not to the sam b t t dist t pec s. B the time th t an an mal had reached, aft n mbe less g ti ns, th deepe t recesses, di use will n th w ha m re less perfectly blit rated its es, and nat ral selection will ft n ha e f fected oth chang s, ch as an in rease n the l gth f the ant nnæ palpi, as compensa ti f blindn ss. N tw thstanding u h mod ificati ns, w m gl t expect till to see in th ca e-animals of Am a, affiniti t th th inhab tants of that co tin nt, and in th se f Europe to th hab tants f th European continent. And thi is th case with som f th Am rican ca e-animals, as I h ar from Pro- fessor Dana and som f th European ca

tants of the two continents on the ordinary view of their independent creation That several of the inhabitants of the caves of the Old and New Worlds should be closely related we might expect from the well known relationship of most of their other productions As a blind species of Bathyscia is found in abundance on shady rocks far from caves the loss of vision in the cave species of this one genus has probably had no relation to its dark habitation for it is natural that an insect already deprived of vision should readily become adapted to dark caverns Another blind genus (Anophthalmus) offers this remarkable peculiarity that the species as Mr Murray observes have not as yet been found anywhere except in caves yet those which inhabit the several caves of Europe and America are distinct but it is possible that the progenitors of these several species whilst they were furnished with eyes may formerly have ranged over both continents and then have become extinct excepting in their present secluded abodes Far from feeling surprise that some of the cave animals should be very anomalous as Agassiz has remarked in regard to the blind fish the Amblyopsis and as is the case with blind Proteus with reference to the reptiles of Europe I am only surprised that more wrecks of ancient life have not been preserved owing to the less severe competition to which the scanty inhabitants of these dark abodes will have been exposed

Acclimatisation

Habit is hereditary with plants as in the period of flowering in the time of sleep in the amount of rain requisite for seeds to germinate &c and this leads me to say a few words on acclimatisation As it is extremely common for distinct species belonging to the same genus to inhabit hot and cold countries if it be true that all the species of the same genus are descended from a single parent form acclimatisation must be readily effected during a long course of descent It is notorious that each species is adapted to the climate of its own home species from an arctic or even from a temperate region cannot endure a tropical climate or conversely So again many succulent plants cannot endure a damp climate But the degree of adaptation of species to the climates under which they live is often overrated We may infer this from our frequent inability to predict whether or not an imported plant will endure our climate and from the number of plants and animals brought from different countries which are here perfectly healthy We have reason to believe that species in a state of nature are closely limited in their ranges by the competition of other organic beings quite as much as or more than by adaptation to particular climates But whether or not this adaptation is in most cases very close we have evidence with some few plants, of their becoming to a certain extent naturally habituated to different temperatures that is they become acclimatised thus the pines and rhododendrons raised from seed collected by Dr Hooker from the same species growing at different heights on the Himalaya were found to possess in this country different constitutional powers of resisting cold Mr Thwaites informs me that he has observed similar facts in Ceylon analogous observations have been made by Mr H C Watson on European species of

duced of species having largely extended within historical times their range from warmer to cooler latitudes and conversely but we do not positively know that these animals were strictly adapted to their native climate though in all ordinary cases we assume such to be the case nor do we know that they have subsequently become specially acclimatised to their new homes so as to be better fitted for them than they were at first

As we may infer that our domestic animals were originally chosen by uncivilised man because they were useful and because they bred readily under confinement and not because they were subsequently found capable of far extended transportation the common and extraordinary capacity in our domestic animals of not only withstanding the most different climates but of being perfectly fertile (a far severer test) under them may be used as an argument that a large proportion of other animals now in a state of nature could easily be brought to bear widely different climates We must not however push the foregoing argument too far on account of the probable origin of some of our domestic animals from several wild stocks the blood for instance of a tropical and arctic wolf may perhaps be mingled in our domestic breeds The rat and mouse cannot be considered as domestic animals but they have been transported by man to many parts of the world and now have a far wider range than any other rodent for they live under the cold climate of Faroe in the

orth and of the Falklands in tl so th, and on many an island in th torrid zones. He ce adapt io t y special climate may be look
cat
to most animals
enduring the most d ff re t climates by man himself and b h d m t c animals, and the fact of th extinct lephant and rhinoceros having formerly ndured a glac al climate, hereas th h ing pecies are w ll trop cal or sub-tropical *in th ir hab ts, gl t ot to be* looked t as anomalies, b t as examples f a ery common flex bilit f constit ti n, brought, und r peculiar circumstances, into action.

H w much of th accl m tisatio of speci *to any peculiar climat* is du t m re hab t and how much t th nat ral selecti n f arı ties ha ing d ff re t inn t constit ti ns, and how much to both m ans comb ed, is an obscure q estion. That hab t custom has some infl nce I must bel both from analogy and from th ncessant ad ce gi n agricult ral wo ks, en in th anci nt n cy lopædias of China, to be ry cautio in transporting an mals from district t an other And as t is n t likel that man sh ld ha ucceeded in selecting so man breeds and b-breeds with con titutions pecially fitted f their wn distri ts, th result must, I thi k, be d t hab t. On th the hand, nat ural selectio would in tably te d t preser those ind iduals which w re born w th const t tions best ad pted t any country hich th y nhab ted I treatises many kind of cult ated plants, certain ari ties are said to w thstand certain limates bett r than th rs this is strikingly sh wn in orks fru t trees p blished in th U ted States, in hich certain ari ties are hab tually recom mended for the north rn and th rs f th southern States and as most of these ari ties are of rece t rigin, th y cannot w their co st t tional diff rences to hab t. Th case of th J rusalem artichok which is propa gated in En land by seed and of which co sequently new ariet es ha not been produced, has e been ad anced, as pro that acclimatisatio annot be ffected f t is now as tender as rr t was Th case also, of the kidn -bean has been often cited for a similar p rpose and th much gre t weight b t t l someone will sow l rn a score of generations, his kid beans so arly that a ery large proportion re destroyed by frost, and th n collect seed from the f w surviv rs, w th care to pre ent accid ntal crosses, nd th n again g t seed from these seedli gs, w tl th sam precauti ns, th periment cannot be said t have been tried N r let it be supposed th t d ff rences in th co t t t n of seedlin k dn y beans v r ppear f r an account has been p blished h w m ich more hard som seedli g are than thers and of this fact I ha myself bserved st iking in ta ces.

O th wh l we m y co cl d th t hab t or use and d suse ha *n some cases*, pl yed a cons d rabl part n th mod ficati n of tl e constit tion and stru t re b t th t th f fect ha oft n been largely combined with and som time o ma t red by th natural selection f innat n ti ns.

Correlated Variation

I m an by th xpress on th t th wh l rganisati n is so tied tog th dur n its growth and d l pm nt tl t when light ari tions in a y one pa t occu and are cum lated thro gh natural selecti n otl r parts become mod fied This is a very impo tant bject most imperfectly und rstood and d bt wh lly d ff rent classes of facts ma be h re easily confo ded t geth We shall presently see that simple inheritance

larvæ naturally tend to affect the tructure of the m ture animal Th sev ral parts f the body which are h m log us, and wh ch t an ea ly embry ni period are id t cal in tru t re and which are ecessarily posed to sim lar co diti ns, seem minently habl to vary in lik mann w see this in the ri ht and l ft sides f th body varying in th same manner in the front and hind l gs, and n in th j w and limbs, ry g t th f the low j w is beli ed by *som an t mists to be h m* log us w th th limbs. Th se t nd n s, I d t d bt m y be *mast red* m re or l ss com pl t ly by nat al selection thus a fam ly of tags nce existed with an antl nly on e ul and if this had been f any gre t use to tl breed, t m gl t probably ha been ren d red permanent by selecti n.

H mologous parts, as has been remarked by som th rs, t nd t col re this i oft n seen in m nstro plants and n thing is m re com mon than th unio f h m lo us parts in n rmal tructures, as in th union of the petals

into a tube Hard parts seem to affect the form of adjoining soft parts it is believed by some authors that with birds the diversity in the shape of the pelvis causes the remarkable diversity in the shape of their kidneys Others believe that the shape of the pelvis in the human mother influences by pressure the shape of the head of the child In snakes according to Schlegel the form of the body and the manner of swallowing determine the position and form of several of the most important viscera

The nature of the bond is frequently quite obscure Isidore Geoffroy St Hilaire has forcibly remarked that certain malconformations frequently and that others rarely co exist without our being able to assign any reason What can be more singular than the relation in cats between complete whiteness and blue eyes with deafness or between the tortoise shell colour and the female sex or in pigeons between their feathered feet and skin betwixt the outer toes or between the presence of more or less down on the young pigeon when first hatched with the future colour of its plumage or again the relation between the hair and teeth in the naked Turkish dog though here no doubt homology comes into play? With respect to this latter case of correlation I think it can hardly be accidental that the two orders of mammals which are most abnormal in their dermal covering viz Cetacea (whales) and Edentata (armadilloes scaly ant eaters &c) are likewise on the whole the most abnormal in their teeth but there are so many exceptions to this rule as Mr Mivart has remarked that it has little value

I know of no case better adapted to show the importance of the laws of correlation and variation independently of utility and therefore of natural selection than that of the difference between the outer and inner flowers in some compositous and umbelliferous plants Every one is familiar with the difference between the ray and central florets of for instance the daisy and this difference is often accompanied with the partial or complete abortion of the reproductive organs But in some of these plants the seeds also differ in shape and sculpture These differences have sometimes been attributed to the pressure of the involucra on the florets or to their mutual pressure and the shape of the seeds in the ray florets of some Compositæ countenances this idea but with the Umbelliferæ it is by no means as Dr Hooker informs me the species with the densest heads which most frequently differ in their inner and outer flowers It might have been thought that the development of the ray petals by drawing nourishment from the reproductive organs causes their abortion but this can hardly be the sole cause for in some Compositæ the seeds of the outer and inner florets differ without any difference in the corolla Possibly these several differences may be connected with the different flow of nutriment towards the central and external flowers we know at least that with irregular flowers those nearest to the axis are most subject to peloria, that is to become abnormally symmetrical I may add as an instance of this fact and as a striking case of correlation that in many pelargoniums the two upper petals in the central flower of the truss often lose their patches of darker colour and when this occurs the adherent nectary is quite aborted the central flower thus becoming peloric or regular When the colour is absent from only one of the two upper petals the nectary is not quite aborted but is much shortened

With respect to the development of the corolla Sprengel s idea that the ray florets serve to attract insects whose agency is highly advantageous or necessary for the fertilisation of these plants is highly probable and if so natural selection may have come into play But with respect to the seeds it seems impossible that their differences in shape which are not always correlated with any difference in the corolla can be in any way beneficial yet in the Umbelliferæ these differences are of such apparent importance—the seeds being sometimes orthospermous in the exterior flowers and cœlospermous in the central flowers —that the elder De Candolle founded his main divisions in the order on such characters Hence modifications of structure viewed by systematists as of high value may be wholly due to the laws of variation and correlation without being as far as we can judge of the slightest service to the species

We may often falsely attribute to correlated variation structures which are common to whole groups of species and which in truth are simply due to inheritance for an ancient progenitor may have acquired through natural selection some one modification in structure and after thousands of generations some other and independent modification and these two modifications having been transmitted to a whole group of descendants with diverse habits would naturally be thought to be in some necessary manner correlated Some other

correlat ns are pparе tly d e to tl e man r n hich t ral select n al act F r m tance, Alph. de Candolle has em ked th t win ed seeds are n e f d i f u ts whi h d or I l ld xplain th s rule by th

fact with wh ch I was much struck wh n e am m r ed and of which many an l g us in l ci anu pl t case rdir carapace in all the p u three h ghly mpo ta t a t ri r segm t of h l d m ly d l ped and f rn shed

C mpensation and Economy of Growth

Th ld Geoff y and Go the propounded t abo t th sam tim th law f compensa- tio o balancem t f growth as Goethe xpressed t, In rd t pe d n de t re f rced t eco mis th th de. I th k this h lds tru t certai xt t w th d mest c prod cti ns if no rishm t fl w to o part r gan in ce s, it arely fl ws, t l ast e cess, t an tl p rt thu it d fficult to g t cow to g m ch milk and to f tt readily Th sam ar t es of th cab- b g d n t y eld ab dant and triti fol g and cop us pply f o l b ri g eed Wl the seeds n fru ts becom t o- ph ed th fru t tself gains larg ly in and jual ty I po ltry a larg t ft f f th rs on tl h ad is g ally accomp ed by a d m ished comb and large b ard by d min ished wattles. W th pec s in a tate f t t hardl be maintai ed th t th l w f rsal pplicat but many good bservers, m re pec ally botanists, b h ts truth. I w ll t, h here g e any in tances, f I see hardly any way f d tin guisl g betwee th ffects, on th hand f part b g larg ly d l ped tl ro gl n t ral select and an tl d adj g part be g red ced l y th m process by d s- se and th tl l and th act al w th d al of trim t from part g to th cess f growth an th and adj ning part.

I pect, also, th t some f th case f compensat wh h l bee ad anced and l k ise som th facts, may b m ged und m re ge al pri pl am ly th t nat al selecti co t lly try g to econ mise ry part f th g zat If u d har ged cond tions of l f tru t re bef re sef l, becomes less sef l ts d m t w ll be f red, f t will prof t tl nd d al t to ha ts trim t asted b ld g p an useless tructure I can ly th d rstand

b l each w uld h a b tt r chan e f s pport g its lf by le n triment be g wasted

Thus as I belie n tural s lect n will tend in the l g run to ed e any pa t of th r gan ati as soon as it becom thr gh h ged h b ts, s perfl o witho t by any m an ca ing som oth r p rt to b l g ly d l ped in a co e po d ng deg e A d con rs ly th t tural s lect n m y p r fectly w ll ceed in l g ly d v l p g an o gan w th t q g as a neces ary com p nsation the d tio f some adjoin ng part.

Multiple Rudimentary and Lowly organised St uctu es are Variable

It seems t b a rul as emarked by th y g Geoffroy both with ri t s d pec th t wh n y part gan p ted m y t m the sam ind d l (as th rt brae snak s, and the t me s n polyandro fl w rs) th n mb r is r ble wh reas th sam p rt organ wh n it oc rs in lesse n mb rs, s onstant. Th sam tl as w ll as som bota ts h v furth remarked that m ltipl p t are trem ly liabl to ary tru ture As eg t bl p- t t to use Prof O xp ss n, s a s gn f l w gan sat th f going tat m ts acco d w th th comm n pin n f t al ts, that be g whi h ta d l n the seal f t re are m re ar bl than those wh ch re h gl r l pre m that lown ss h m ans th t th se al part f th g nisa ti n h bee b t little pecialised f par t cular fun ti ns and as l g as th sam part

has to perform diversified work, we can perhaps see why it should remain variable that is why natural selection should not have preserved or rejected each little deviation of form as carefully as when the part has to serve for some one special purpose In the same way a knife which has to cut all sorts of things may be of almost any shape whilst a tool for some particular purpose must be of some particular shape Natural selection it should never be *forgotten* can act *solely* through and for the advantage of each being

Rudimentary parts as it is generally admitted are apt to be highly variable We shall have to recur to this subject and I will here only add that their variability seems to result from their uselessness and consequently from natural selection having had no power to check deviations in their structure

A Part developed in any Species in an extraordinary degree or manner in comparison with the same Part in allied Species tends to be highly variable

Several years ago I was much struck by a remark to the above effect made by Mr Waterhouse Professor Owen also seems to have come to a nearly similar conclusion It is hopeless to attempt to convince any one of the truth of the above proposition without giving the long array of facts which I have collected and which cannot possibly be here introduced I can only state my conviction that it is a rule of high generality I am aware of several causes of error but I hope that I have made due allowance for them It should be understood that the rule by no means applies to any part however unusually developed unless it be unusually developed in one species or in a few species in comparison with the same part in many closely allied species Thus the wing of a bat is a most abnormal structure in the class of mammals but the rule would not apply here because the whole group of bats possesses wings it would apply only if some one species had wings developed in a remarkable manner in comparison with the other species of the same genus The rule applies very strongly in the case of secondary sexual character when displayed in any unusual manner The term secondary sexual characters used by Hunter relates to characters which are attached to one sex but are not directly connected with the act of reproduction The rule applies to males and females but more rarely to the females as they seldom offer remarkable secondary sexual characters The rule being so plainly applicable in the case of secondary sexual characters, may be due to the great variability of these characters whether or not displayed in any unusual manner—of which fact I think there can be little doubt But that our rule is not confined to secondary sexual characters is clearly shown in the case of hermaphrodite cirripedes I particularly attended to Mr Waterhouse s remark whilst investigating this Order and I am fully convinced that the rule almost always holds good I shall in a future work give a list of all the more remarkable cases I will here give only one as it illustrates the rule in its largest application The opercular valves of sessile cirripedes (rock barnacles) are in every sense of the word very important structures and they differ extremely little even in distinct genera but in the several species of one genus Pyrgoma these valves present a marvelous amount of diversification the homologous valves in the different species being sometimes wholly unlike in shape and the amount of variation in the individuals of the same species is so great that it is no exaggeration to state that the varieties of the same species differ more from each other in the characters derived from these important organs than do the species belonging to other distinct genera

As with birds the individuals of the same species inhabiting the same country vary extremely little I have particularly attended to them and the rule certainly seems to hold good in this class I cannot make out that it applies to plants and this would have seriously shaken my belief in its truth had not the great variability in plants made it particularly difficult to compare their relative degree of variability

When we see any part or organ developed in a remarkable degree or manner in a species the fair presumption is that it is of high importance to that species nevertheless it is in this case eminently liable to variation Why should this be so On the view that each species has been independently created with all its parts as we now see them I can see no explanation But on the view that groups of species are descended from some other species and have been modified through natural selection I think we can obtain some light First let me make some preliminary remarks If in our domestic animals any part or the whole animal be neglected and no selection be ap-

n tance, th comb in th mot
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m ich lo er period arly con

full play and thus th
fluctuating cond tion. B t what h re more particularly concern is, that those po ts in our d mestic animals, which at th prese t tim are und rgoin rapid cha by co tin ued selection, are also emin tl liabl to var iation. Look at th indi d als of th sam breed of th pigeon, and see what a prod gious amount of diff rence th re is in the beaks of tumblers, in th beaks and w ttle of carri rs, in the carriage and tail of fantails, &c., these being the points n w mainl tt nded to by English fanciers. E en tl sam ub-breed as in that of the sho t-faced t mble t i notorious difficult t breed arl perfect birds, man departi g wid l from th stand ard. There ma truly be said to be con tant struggle going o between, o th hand, the tendency to rev rsio to less perfect tate as w ll as an inn t tend ncy t w variations, and, th the hand, the pow of stead selectio to keep th breed tru In th long run selectio gains tl d and w do not xpect t fail so compl t l as to breed a bird as coarse as comm t mbl p eon from good short faced train. B t as lo as selectio is rap ll goin on, m h ariabilit in the parts und rgoi mod fication ma al y be expected

N w let us t rn t nature Wh n part has been d loped an traordi nary mann n any one pecies, compared w th th oth species of the sam g us, w ma oncl d that this part has un l rgoi an traord nary amount of mod fication since the period wh n the se eral pecies b anched off from th com mon progenito of tl genus. This period will seldom be remot in an trem d ree as pecies rarely end re f more than geo logical period. An extraordi nary amount of modification impli an usuall larg and long-cont ued mou t of riab lity which has continually bee accum lated by natural selection f the ben fit of the pecies. B t as the ariability of the traordinarily d l oped part or organ has bee so great and long continued within period not xcessi ely re

co rse of tim cease and that th most ab normally d loped rgan ma be mad con ta t I see no reason to do bt. H nce wh n h ev r abnormal t may be h s

existed ccordin to o theory f r an im mense period in nearly the same tat and th it has om not to be more variable than

of th nd luals arising in th required man n and d ree and b th co t n ed rejection of those t nd t re rt t a former and less modified condition.

Spec fic Ch racters mo e V ariable than Ge e ic Ch acters

The principle discussed under th last head m may be pplied t present s bject. It is not rious that pecific chara t rs are more var iabl than g n ric. To xplain b a imple e mple what is meant if in a large g nus of plants som species had bl fl rs and som had red, th colou would be onl a specifi haract and n would be surprised at ne of tl blu spec es arvin int red, o con rsel b t if all th spec es had bl flow rs, th colo w uld becom a gen ric haracter and ts ariatio w ld be a more unusual cir cum tance. I hav hosen this example be cause the plan tion which most naturalists w uld ad ance is n t h re pplicable nam l that pecific haract rs are more variable than generic, bec use th y are tak n from parts of less ph siological importance than those com m nly used for classin gen ra. I beli e this explanatio partly et onl indirectl tru I shall, how ha t ret rn to this point in the chapt on Classification. It w uld be al most perfluou to add ce d nce in s p port of the statement, that ordinary specific

characters are more variable than generic but with respect to important characters I have repeatedly noticed in works on natural history that when an author remarks with surprise that some important organ or part which is generally very constant throughout a large group of species *differs* considerably in closely allied species it is often *variable* in the individuals of the same species And this fact shows that a character which is generally of generic value when it sinks in value and becomes only of specific value often becomes variable though its physiological importance may remain the same Something of the same kind applies to monstrosities at least Isidore Geoffroy St Hilaire apparently entertains no doubt that the more an organ normally differs in the different species of the sam

I ... independently created why should that part of the structure which differs from the same part in other independently created species of the same genus be more variable than those parts which are ...

... marked and fixed varieties we might expect often to find them still continuing to vary in those parts of their structure which have varied within a moderately recent period and which have thus come to differ Or to state the case in another manner —the points in which all the species of a genus resemble each other and in which they differ from allied genera are called generic characters and these characters may be attributed to inheritance from a common progenitor for it can rarely have happened that natural selection will have modified several distinct species fitted to more or less widely-different habits in exactly the same manner and as these so-called generic characters have been inherited from before the period when the several species first branched off from their common progenitor and subsequently have not varied or come to differ in any degree or only in a slight degree it is not probable that they should ...ary ... he ... ies ... racters and as these specific characters have varied and come to differ since the period when the species branched off from a common progenitor it is probable that they should still often be in some degree variable —at least more variable than those parts of the organisation which have for a very long period remained constant

Secondary Sexual Characters Variable—I think it will be admitted by naturalists, without my entering on details that secondary sexual characters are highly variable It will also be admitted that species of the same group differ from each other more widely in their secondary sexual characters than in other parts of their organisation compare for instance the amount of difference between the males of gallinaceous birds in which secondary sexual characters are strongly displayed with the amount of difference between the females. The cause of the original variability of these characters is not manifest ...

... on than ordinary selection as it does not entail death but only gives fe...

... ey are highly variable sexual selection will have had a wide scope for action and may thus have succeeded in giving to the species of the same group a greater amount of difference in these than in other respects

It is a remarkable fact that the secondary differences between the two sexes of the same species are generally displayed in the very same parts of the organisation in which the species of the same genus differ from each other Of this fact I will give in illustration the two first instances which happen to stand on my list and as the differences in these cases are of a very unusual nature the relation can hardly be accidental The same number of joints in the tarsi is a character common to very large groups of beetles but in the Engida as Westwood has remarked the number varies greatly and the number likewise differs in the two sexes of the same species Again in the fossorial hymenoptera the neuration of the wings is a character of the highest importance because common to large groups but in certain genera the neuration differs in the different species and likewise in the two sexes of the same species Sir J Lubbock has recently remarked that several minute crustaceans offer excellent illustrations of this law In Pontella for instance the sexual characters are afforded mainly by the anterior antennæ and by the fifth pair of legs the specific differences also are principally given by these organs This

rel tion has a clear meani g n my vi w I look t ll th spec es f th sam g as h v ng as certai ly descended f m comm p g n t h tw se e f ny pec es.
C

part

t f by t al and e u l select n rd r to fit the se al pec t tl se e al places the eco my f nat and l k w e t fit the tw sc es f th same pec e to ach tl to fit th m l t truggl w th th r m l f the poss ss o f th f m le

F nally th n, I co l d that tl great r variab l ty f pec f laract rs th se h l d t gu l speci from pec e than f g ric charact s, r tl se wl ch re po s sed by all the pec —th t tl f q t trem n b l t f any pa t wl l d l p- ed spec t aord y m nn compar so w tl tl sam part t co g rs and th i ght d gre f n b l ty a part, l traord nly t ma b d loned f t be comm t wl le gro p f

se al and rd rs pec fi d ll re ce re g ally displayed tl sam parts f th

h l rited m l omm —t p rts l d l rece tl and l g l ned b g m re l k ly t ll t g rs g tl an t ts h l l lo g bec l ted d l t ed —to nat l sel et l g m re o l ss compl t l accord g t tl l pse f t m rs ast red tl t d t re rs and to f tl ariab lit —t se l select b g less rigid than rd select —and to nat ns tl sam parts h g bec ac cu lated by t ral l se l sel ct ar l t g bee tl ad pted f seco dary se l an l f l ary p rposes.

Dist ct Spec p nt al g l n f that l rely f Sp cie ft as m f l aracter pr per t all d Spec re rt t m ft l Ch acter f ea ly l o- g t — Th se propo tio w ll be most read l nd rstood b lock g t t the are Tl most l t t breed d tl p geo cou tries l ly part prese t l ar t th re ersed f tl rs tl h ad and th

f ath s n th feet,—cl racte s not po ses ed by th b rig nal rock p geon th th n a e anal gous tio s n two o m r di tinct races Tl f eq ent p nc f f u teen or n sixt n tail f the s n the p ter m y b co d red as a vari t n rep ese t g the no mal tructu e of an the ace th fan ta l I p e m th t e w ll d ubt that all such an logo s ari t s re d t the se al race f the p geon ha inh r ted f om a comm n pare t tl m const tut on and ten d n y to t n hen ct d n by milar unkn wn nfl nce In tl e eg tabl kingd m w l a case f a al u ar t n in th l d t ms as commo ly alled roots f

th b n t o th case will th n be o r an g u ar t n n t o o-call d d tin t pe cies and t these thi d m y be added nam ly tl comm n t rn p Accord g t the d n

three plant n t to the *re a a* of commu ty f d sce t, and co seq nt tend n y to vary in lik ma n but t thre sep t y t l sely r lated ts f c t n. Many m l cases f an l g u ari t n ha been b- er d by N din n tl gr t g rd f m ly and by ar utl m r ce l S m lar

b rs th w gs, wl t l ns a b t th d f tl tail w th tl te feath t rn lly edged th bas with wh t As all th se m ks re haract ri t f tl e p t rock p geo I pre um th t n w ll d bt tl t tl is case f ion, and t f w t nal t n ppe ing n th se l breed W m y I th k, confid tly com t tl concl beca as w l se th col red k re m ntly l ble t ppe r th rossed ffsp g f tw distin t d d ff tly col red breed d th ase tl re is noth g in th t rnal co d t ns f l l to ca se tl re ppe ce f th sl ty bl w tl th se l m ks, b nd tl infl nce of tl m re act f crossing the law f in h ritance.

No doubt it is a very surprising fact that characters should reappear after having been lost for many, probably for hundreds of generations. But when a breed has been crossed only once by some other breed, the offspring occasionally show for many generations a tendency to revert in character to the foreign breed—some say, for a dozen or even a score of generations. After twelve generations, the proportion of blood, to use a common expression, from one ancestor, is only 1 in 2048; and yet, as we see, it is generally believed that a tendency to reversion is retained by this remnant of foreign blood. In a breed which has not been crossed, but in which *both* parents have lost some character which their progenitor possessed, the tendency, whether strong or weak, to reproduce the lost character might, as was formerly remarked, for all that we can see to the contrary, be transmitted for almost any number of generations. When a character which has been lost in a breed, reappears after a great number of generations, the most probable hypothesis is, not that one individual suddenly takes after an ancestor removed by some hundred generations, but that in each successive generation the character in question has been lying latent, and at last, under unknown favourable conditions, is developed. With the barb pigeon, for instance, which very rarely produces a blue bird, it is probable that there is a latent tendency in each generation to produce blue plumage. The abstract improbability of such a tendency being transmitted through a vast number of generations, is not

sometimes thus inherited.

As all the species of the same genus are supposed to be descended from a common progenitor, it might be expected that they would occasionally vary in an analogous manner; so that the varieties of two or more species would resemble each other, or that a variety of one species would resemble in certain characters another and distinct species,—this other species being, according to our view, only a well-marked and permanent variety. But characters exclusively due to analogous variation would probably be of an unimportant nature, for the preservation of all functionally important characters will have been determined through natural selection, in accordance with the different habits of the species. It might further be expected that the species of the

same genus would occasionally exhibit reversions to long lost characters. As, however, we do not know the common ancestors of any natural group, we cannot distinguish between reversionary and analogous characters. If, for instance, we did not know that the parent rock-pigeon was not feather-footed or turn-crowned, we could not have told whether such characters in our domestic breeds were reversions or only analogous variations; but we might have inferred that the blue colour was a case of reversion from the number of the markings, which are correlated with this tint, and which would not probably have all ap-

appearing when differently coloured breeds are crossed. Hence, although under nature it must generally be left doubtful, what cases are reversions to formerly existing characters, and what are new but analogous variations, yet we ought, on our theory, sometimes to find the varying offspring of a species assuming characters which are already present in other members of the same group. And this undoubtedly is the case.

The difficulty in distinguishing variable species is largely due to the varieties mocking, as it were, other species of the same genus. A considerable catalogue, also, could be given of forms intermediate between two other forms, which themselves can only doubtfully be ranked as species; and this shows, unless all these closely allied forms be considered as independently created species, that they have in varying assumed some of the characters of the

occasionally vary so as to resemble, in some degree, the same part or organ in an allied species. I have collected a long list of such cases; but here, as before, I lie under the great disadvantage of not being able to give them. I can only repeat that such cases certainly occur, and seem to me very remarkable.

I will, however, give one curious and complex case, not indeed as affecting any important character, but from occurring in several species of the same genus, partly under domestication and partly under nature. It is a case almost certainly of reversion. The ass sometimes has very distinct transverse bars on its legs, like those on the legs of the zebra: it has been asserted that these are plainest in the

foal, and, from inq iries which I ha e made, I bel thus t be true Th tripe on the should s sometimes d bl and is ery ariable length and tl A white ass, but not an all o, has been described w th ut eith r spinal r sh ld r tripe and these tripes are som times v ol scure or act ally quit lost, dark-col ured asse The k dian of Pallas said to ha bee een w th a d u ble h ld tripe. Mr Bl th has seen a pecimen of tl hemio us w th a d tinct ll t pe ll ugh t prope l has n

zebra e tl e bod is with t bars n the leg b t D Gray has f gured specim n th ery cl t bra lik b rs n the hocks.

W th respect t th h se I h e collected ases E gland f th p ial t pe in h rses of the most d t t breeds, d f all col trans rse b rs tl l g re t are in d ns, mouse-duns, a l in o nst e hest t faint hould t pe v som t mes be seen in d ns, nd I h see a trace in b y horse My so mad caref l e an tio d k tch for m of dun B lg art l rse th d u ble tripe ad h ll d w th l g stripes I ha myself see l D nshire pon and mall d W l l po y l as been caref ll described t m both w th th e parallel tripes ach l ld

I tl rtl west pa t f I d th Katty ar breed f h rses so g rally triped that. I l from C l l Pool wh xam in l tl breed f th In G rnm t, horse tl out t pes t co is l red as pure -bred The p l y triped the le are g nerally barred an l tl l ld tripe, hich is som t mes d bl an l some-tim treb l is comm tl l of tl face moreo is som ti t ped Tl tripes are of p lainest th foal and som t mes q t d sappear old l ses. Col l Pool has seen both g nd l Katt war h se striped h fi t foaled I ha also reaso t su pect, from if rmat g m l M W W Ed ards, tl t th th E glisl racehorse th p nal tripe much co m in tl foal than in the f ll gro mal I ha m self recentl bred f al from bay mare (offsp ring of T k man horse and Flemish mare) by bay English acehorse this foal when a week old as marked on ts hind uart rs and

ts forehead with numerous, very narrow dark ebra like bars, and ts legs w e feebly tr ped all the tripes soon d sappeared complet ly W tl ut h re ent ring n furth r d tail I may stat that I have collected case of l g and sh ld r trip s in h ses f v ry diffe ent breeds in ar s countr es f m Britain to eastern Chin nd from N rw y in the n tl to th Mal y Arch pelag in th south In all parts f the wo ld these tripes occur far often est in duns and m use-d n b tl e term d n larg ra g of col ur is incl ded, from o e betwee brown and black to cl se approach t m col

from se ral abo ginal pecie —one f wh h the d as t ped nd th t th abo descr bed ppearan es a e ll d t anci t cro ses w th th du tock B t tl w m y b safely rejected f it is h gl ly mprobabl tl t tl e hea y B lg an c t h se W lsh

o e pposed abori inal stock

N w l t us t rn to the ffect f rossin th sev al pecies f th horse g nus. R llin as-se ts, th t th comm mul from th ass a d horse is part cularly pt to h e bars on t l gs accord to M Gosse i c rt in part f th Un ted States abo t n ne t of ten mul ha triped le s I nce saw a mul with ts l gs so m ch str ped that any m ght h e tho ght that t w s a hybrid b and M W C Mart in h e cell t tre tise n th l rse has gi en figure f m l r mule I f col red d wings, wh ch I h e seen f h yb d bet en th ass and zebra, th l g w re m l m re plainly barred than the rest f th bod and n one f tl m th re was a d bl l ld tripe In Lord M rt n fam us hyl rid from ch tn t mare and m l quagga, tl hybrid and en th p re ff spn g bseq tly prod ced from th sam mare b black Ar b an w re mu h m plainly b red across th l gs than ev n the pure q agga. Lastl and this an the m t remarkabl case, hybrid has bee figured by D Gray (and h nf rms m tl t he kn w f a second case) from th ass and th l mi and tl h ybrid, th gh th ass ly occasi ally has tripe ts l g and tl l m s has and has t n sl uld tripe n rth less had all fou leg barred and had

three short shoulder stripes like those on the dun Devonshire and Welsh ponies, and even had some zebra-like stripes on the sides of its face. With respect to this last fact, I was so convinced that not even a stripe of colour appears from what is commonly called chance, that I was led solely from the occurrence of the face-stripes on this hybrid from the ass and hemionus to ask Colonel Poole whether such face-stripes ever occurred in the eminently striped Kattywar breed of horses, and was, as we have seen, answered in the affirmative.

What now are we to say to these several facts? We see several distinct species of the horse genus becoming, by simple variation, striped on the legs like a zebra, or striped on the shoulders like an ass. In the horse we see this tendency strong whenever a dun tint appears—a tint which approaches to that of the general colouring of the other species of the genus. The appearance of the stripes is not accompanied by any change of form or by any other new character. We see this tendency to become striped most strongly displayed in hybrids from between several of the most distinct species. Now observe the case of the several breeds of pigeons: they are descended from a pigeon (including two or three sub-species or geographical races) of a bluish colour, with certain bars and other marks; and when any breed assumes by simple variation a bluish tint, these bars and other marks invariably reappear; but without any other change of form or character. When the oldest and truest breeds of various colours are crossed, we see a strong tendency for the blue tint and bars and marks to reappear in the mongrels. I have stated that the most probable hypothesis to account for the reappearance of very ancient characters, is—that there is a *tendency* in the young of each successive generation to produce the long-lost character, and that this tendency, from unknown causes, sometimes prevails. And we have just seen that in several species of the horse genus the stripes are either plainer or appear more commonly in the young than in the old. Call the breeds of pigeons, some of which have bred true for centuries, species; and how exactly parallel is the case with that of the species of the horse genus! For myself, I venture confidently to look back thousands on thousands of generations, and I see an animal striped like a zebra, but perhaps otherwise very differently constructed, the common parent of our domestic horse (whether or not it be descended from one or more wild stocks) of the ass, the hemionus, quagga, and zebra.

He who believes that each equine species was independently created, will, I presume, assert that each species has been created with a tendency to vary, both under nature and under domestication, in this particular manner, so as often to become striped like the other species of the genus; and that each has been created with a strong tendency, when crossed with species inhabiting distant quarters of the world, to produce hybrids resembling in their stripes, not their own parents, but other species of the genus. To admit this view is, as it seems to me, to reject a real for an unreal, or at least for an unknown, cause. It makes the works of God a mere mockery and deception; I would almost as soon believe with the old and ignorant cosmogonists, that fossil shells had never lived, but had been created in stone so as to mock the shells living on the sea-shore.

Summary.—Our ignorance of the laws of variation is profound. Not in one case out of a hundred can we pretend to assign any reason why this or that part has varied. But when

eties of the same species, and the greater differences between species of the same genus. Changed conditions generally induce mere fluctuating variability, but sometimes they cause direct and definite effects; and these may become strongly marked in the course of time, though we have not sufficient evidence on this head. Habit in producing constitutional peculiarities, and use in strengthening and disuse in weakening and diminishing organs, appear in many cases to have been potent in their effects. Homologous parts tend to vary in the same manner, and homologous parts tend to cohere. Modifications in hard parts and in external parts sometimes affect softer and internal parts. When one part is largely developed, perhaps it tends to draw nourishment from the adjoining parts; and every part of the structure which can be saved without detriment will be saved. Changes of structure at an early age may affect parts subsequently developed; and many cases of correlated variation, the nature of which we are unable to understand, undoubtedly occur. Multiple parts are variable in number and in structure, perhaps arising from such parts not having been closely specialised for any particular function, so that

their modifications have not been closely checked by natural selection. It follows probably from this same cause, that organic beings low in the scale are more variable than those standing higher in the scale, and which have their whole organisation more specialised. Rudimentary organs, from being useless, are not regulated by natural selection, and hence are variable. Specific characters—that is, the characters which have come to differ since the several species of the same genus branched off from a common parent—are more variable than generic characters, or those which have long been inherited, and have not differed from this same period. In these remarks we have referred to special parts or organs being still variable because they have recently varied and thus come to differ; but we have also seen in the second chapter that the same principle applies to the whole individual; for in a district where many species of a genus are found—that is, where there has been much former variation and differentiation, or where the manufactory of new specific forms has been actively at work—in that district and amongst these species, we now find, on an average, most varieties. Secondary sexual characters are highly variable, and such characters differ much in the species of the same group. Variability in the same parts of the organisation has generally been taken advantage of in giving secondary sexual differences to the two sexes of the same species, and specific differences to the several species of the same genus. Any part or organ developed to an extraordinary size or in an extraordinary manner in comparison with the same part or organ in the allied

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er degree than other parts; for variation is a long-continued and slow process, and natural selection will in such cases not as yet have had time to overcome the tendency to further variability and to reversion to a less modified state. But when a species with any extraordinarily developed organ has become the parent of many modified descendants—which on our view must be a very slow process, requiring a long lapse of time—in this case, natural selection has succeeded in giving a fixed character to the organ, in however extraordinary a manner it may have been developed. Species inheriting nearly the same constitution from a common parent, and exposed to similar influences, naturally tend to present analogous variations, or these same species may occasionally revert to some of the characters of their ancient progenitors. Although new and important modifications may not arise from reversion and analogous variation, such modifications will add to the beautiful and harmonious diversity of nature.

Whatever the cause may be of each slight difference between the offspring and their parents—and a cause for each must exist—we have reason to believe that it is the steady accumulation of beneficial differences which has given rise to all the more important modifications of structure in relation to the habits of each species.

CHAPTER VI

DIFFICULTIES OF THE THEORY

Long before the reader has arrived at this part of my work a crowd of difficulties will have occurred to him Some of them are so serious that to this day I can hardly reflect on them without being in some degree staggered but to the best of my judgment the greater number are only apparent and those that are real are not I think fatal to the theory

These difficulties and objections may be classed under the following heads —First why if species have descended from other species by fine gradations do we not everywhere see innumerable transitional forms? Why is not all nature in confusion instead of the species being as we see them well defined?

Secondly is it possible that an animal having for instance the structure and habits of a bat, could have been formed by the modification of some other animal with widely different habits and structure? Can we believe that natural selection could produce on the one hand an organ of trifling importance such as the tail of a giraffe which serves as a fly flapper and *on the other hand an organ so wonderful as* h [illegible] ?

[illegible]

cells and which has practically anticipated the discoveries of profound mathematicians?

Fourthly how can we account for species when crossed being sterile and producing sterile offspring whereas when varieties are crossed their fertility is unimpaired?

The two first heads will here be discussed some miscellaneous objections in the following chapter Instinct and Hybridism in the two succeeding chapters

On the Absence or Rarity of Transitional Varieties —As natural selection acts solely by the preservation of profitable modifications each new form will tend in a fully stocked country to take the place of and finally to exterminate its own less improved parent form and other less favoured forms with which it comes into competition Thus extinction and natural selection go hand in hand Hence if we look at each species as descended from some unknown form both the parent and all the transitional varieties will generally have been exterminated by the very process of the formation and perfection of the new form

But, as by this theory innumerable transitional forms must have existed why do we not find them embedded in countless numbers in the crust of the earth? It will be more convenient to discuss this question in the chapter on the Imperfection of the Geological Record and I will here only state that I believe the answer mainly lies in the record being incomparably less perfect than is generally supposed The crust of the earth is a vast museum but the natural collections have been imperfectly made and only at long intervals of time

But it may be urged that when several closely allied species inhabit the same territory we surely ought to find at the present time many transitional forms Let us take a simple case in travelling from north to south over a continent we generally meet at successive intervals with closely allied or representative species evidently filling nearly the same place in the natural economy of the land These *representative species often meet and interlock* and as the one becomes rarer and rarer the other becomes more and more frequent, till the one replaces the other But if we compare these species where they intermingle they

[illegible]

each By my theory these allied species are descended from a common parent and during the process of modification each has become adapted to the conditions of life of its own region and has supplanted and exterminated its original parent form and all the transitional varieties between its past and present states Hence we ought not to expect at the present time to meet with numerous transitional varieties in each region though they must have existed there and may be embedded there in a fossil condition But in the intermediate region having intermediate conditions of life why *do we not now find closely linking intermediate varieties?* This difficulty for a long time quite confounded me But I think it can be in large part explained

In the first place we should be extremely cautious in inferring because an area is now

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For forms existing in larger numbers will have a better chance within any given period of presenting further favourable variations for natural selection to seize on than will the rarer forms which exist in lesser numbers Hence the more common form in the race for life will tend to beat and supplant the less common forms for these will be more slowly modified and improved It is the same principle which as I believe accounts for the common species in each country as shown in the second chapter presenting on an average a greater number of well marked varieties than do the rarer species I may illustrate what I mean by supposing three varieties of sheep to be kept one adapted to an extensive mountainous region a second to a comparatively narrow hilly tract and a third to the wide plains at the base and *that the inhabitants are all trying with equal* steadiness and skill to improve their stocks by selection the chances in this case will be strongly in favour of the great holders on the mountains or on the plains improving their breeds more quickly than the small holders on the intermediate narrow hilly tract and consequently the improved mountain or plain breed will soon take the place of the less improved hill breed and thus the two breeds which originally existed in greater numbers will come into close contact with each other without the interposition of the supplanted intermediate hill variety

To sum up I believe that species come to be tolerably well defined objects and do not at any one period present an inextricable chaos of varying and intermediate links first because new varieties are very slowly formed for variation is a slow process and natural selection can do nothing until favourable individual differences or variations occur and until a place in the natural polity of the country can be better filled by some modification of some one or more of its inhabitants And such new places will depend on slow changes of climate or on the occasional immigration of new inhabitants and probably in a still more important degree on some of the old inhabitants becoming slowly modified with the new forms thus produced and the old ones acting and reacting on each other So that in any one region and at any one time we ought to see only a few species presenting slight modifications of structure in some degree permanent and this assuredly we do see

Secondly areas now continuous must often have existed within the recent period as isolated portions in which many forms more especially amongst the classes which unite for each birth and wander much may have separately been rendered sufficiently distinct to rank as representative species In this case intermediate varieties between the several representative species and their common parent must formerly have existed within each isolated portion of the land but these links during the process of natural selection will have been *supplanted and exterminated* so that they will no longer be found in a living state

Thirdly when two or more varieties have *been formed in different portions of a strictly* continuous area intermediate varieties will it is probable at first have been formed in the intermediate zones but they will generally have had *a short duration* For these intermediate varieties will from reasons already assigned (namely from what we know of the actual distribution of closely allied or representative species and *likewise of acknowledged* varieties) exist in the intermediate zones in lesser numbers than the varieties which they tend to connect From this cause alone the intermediate varieties will be liable to accidental extermination and during the process of further modification through natural selection they will almost certainly be beaten and supplanted by the forms which they connect for these from existing in greater numbers will in the aggregate present more varieties and thus be further improved through natural selection and gain further advantages

Lastly looking not to any one time but to all time if my theory be true numberless intermediate varieties linking closely together all the species of the same group must assuredly have existed but the very process of natural selection constantly tends as has been so often remarked to exterminate the parent forms and the intermediate links Consequently evidence of their former existence could be found only amongst fossil remains which are preserved as we shall attempt to show in a future chapter in an extremely imperfect and intermittent record

On the Origin and Transitions of Organic Beings with peculiar Habits and Structure —It has been asked by the opponents of such views as I hold how for instance could a land carnivorous animal have been converted into one with aquatic habits for how could the animal in its *transitional state have subsisted It would be* easy to show that there now exist carnivorous

animals presenting close interm d ate grad s from tr tly t rre trial t q t c hab ts and as ach ısts by a trı ggl f r lıf t ı clear that acl m t b well ad pted to ts place ın nature Look t th *Mustela ɹısı n of N* th Am a, wh ch has wel bed feet, and wh ch resembl an ott ıts f r short l g and f rm f tail. D n th mm r th mal dı es f and preys fi h, b t d ng the lo g wı te t l e tl fro en w t rs, a d preys, lık tl pole-cat o m and land mals If d ff re t case had bee tak n, and t had been asked how an ınsect ro quadruped co ld poss bly b been co erted ı to fly ıng b t, th qu t ld h b n far more difficult to an Y t I th nk u h d ffi lties ha e bttl w ght

H re, as oth r occas ns I h und a h y dısad antag f t f th many trık g case wl ch I h e collected I can nl gı o tn tance f t ans t al hab ts and tru t all ed pec d f d fied h l ts, tl r co tant occas al, ın the sam pec s. Y d t seems to m that noth g l ss than l g h t f h cas ffi t to l ssc th d ffi lty ın any par tıcular case lık th t f th b t.

Look t tl famıly f sq rrels here we h th fi est g ad t from an mal w th th ır tails ly l gl tly fl tt ed and f om thers, as S J R hardso l as marked w th th post rıo part f th bod rather w d and th tl k tl flanks th f ll t th so-c lled fl g sq ırrels and fly g squır l h th l mb and th base f th tail t d by broad panse f kın wh ch serves as paracl t l ll w th m to glıd thro gl tl t ast h g distance from tree to tree W ann t d bt that ach truct re ıs f use t ach kı d f sq rrel ı ıts co try l y nabl g t t sc pe b rd beasts f prey to collect food m q ckly as tl re ıs reaso to bel to l sse th dang from occas nal falls. B t t doe t follow from this fact that th tructure f ach sq rrel th be t th t t ıs poss bl t co cei nd all possıbl co d tı ns. Let the l mat and g tat chang l t tl com petıng rod ts w beasts f prey mmı gr t ld es becom mod f d d all anal gy w ld l ad to bel tl t some t least f tl sq rrels w ld d crease m be been m t rm nated nless tl y also becom mod fied and mpro ed tructure corresp nd g man Tl ref re I can see no difficulty more pecıally nd r changıng cond tı ns f lıf ın the continued preserva tıon f ındı d als with f ll r and f ller flank m mbr n each modificat n bein us ful

flyıng lemu wh ch forme ly was anked am g t b ts, b t ıs n w bel d t belo g to th Insect a. In t em ly w de flank m mb ane tretches from the co ers f the j w to th tail and ın lud s the l mbs with th

w th the tu nsec a, — —
culty ın ppo ıng that ch l nks f m ly xısted and that acl w d el ped n the sam manne as w th the l ss pe fectly gl dıng q rrels each grade of tru ture ha ng been us f l t ıts poss sso No an I see any ı pe abl d fficulty ın f rtl r b lıe g th t

— —
taın b ts ın wh ch th w g memb ane xtends *from th top f th shoulder to the tail* and n l des th hınd l gs, w p h p see trace f appar tus rıgınally fitted for glıdıng *thro gh th ther than for fl ght.*

If ab ut d n g n ra f birds were to b com e tın t, wh w ld ha e v tured to rm se that b rd m ght h ex ı d which

— —
lık the pe g ın as sails, lık tl t ch and fun t ally f r n purpose lık the Apt ryx Y t the truct re f ach f these birds ıs good f t, und th co d tı ns f life to which ıt s xposed f each has to lı e by a str ggl but t ıs n t ecessarıly the be t poss ble under all poss bl co d tı s. It must n t b ınf rred from th se remarks that any f the grad f wıng tru ture h re all ded to which pe h ps m y all be th re lt of dıs se ınd cat th t p by which b rds actually acq ıred their perfect pow f fl ght b t th y serve to sh w what dı rsıfied m ans f transıtı n are t l ast poss ble

See g th t f w m mbers f ch wate breathing classes as th Cru tace and M llus ca are adapted to lıv on th land and seeing

that we have flying birds and mammals flying

lightly rising and turning by the aid of their fluttering fins might have been modified into perfectly winged animals If this had been effected who would have ever imagined that *in an early transitional state they had been the* inhabitants of the open ocean and had used their incipient organs of flight exclusively as far as we know to escape being devoured by other fish?

When we see any structure highly perfected for any particular habit, as the wings of a bird for flight we should bear in mind that animals displaying early transitional grades of the structure will seldom have survived to the present day for they will have been supplant*ed by their successors which were gradually* rendered more perfect through natural selection Furthermore we may conclude that transitional states between structures fitted for very different habits of life will rarely have been developed at an early period in great numbers and under many subordinate forms Thus to return to our imaginary illustration of the flying fish it does not seem probable that fishes capable of true flight would have been

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feed on exotic plants or exclusively on artificial substances *Of diversified habits innumer*able instances could be given I have often watched a tyrant flycatcher (*Saurophagus sulphuratus*) in South America, hovering over one

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cies and to the other pecies of the same genus, we might expect that such individuals would occasionally give rise to new species having anomalous habits and with their structure either slightly or considerably modified from that of their type And such instances occur in nature Can a more striking instance of adaptation be given than that of a woodpecker for climbing trees and seizing insects in the chinks of the bark Yet in North America there are woodpeckers which feed largely on fruit, and others with elongated wings which chase insects on the wing On the plains of La Plata, *where hardly a tree grows* there is a woodpecker (*Colaptes campestris*) which has two *toes before and two behind a long pointed* tongue pointed tail feathers sufficiently stiff to support *the bird in a vertical position on a* post but not so stiff as in the typical woodpeckers and a straight strong beak The beak, however is not so straight or so strong as in the typical woodpeckers but it is strong enough to bore into wood Hence this Colaptes in all the essential parts of its structure is a

clared yet as I can assert, not only from my own observation but from those of the accurate Azara, in certain large districts it does not climb trees, and it makes its nest in holes in banks[1] *In certain other districts,* however the same woodpecker as Mr Hudson states fre*quents trees and bores holes in the trunk* for its nest. I may mention as another illustration *of the varied habits of this genus,* that a

Mexican Colaptes has been described by De Saussure as boring h les into hard wood in order to lay up a store of acorns.

Petrels are the most erial and oceanic of birds, but in th qu t sounds f Tierra del Fuego, the *P ffi uria berardi* in ts ge ral habits, in its astonishing pow r f d ing in ts manner of swimming and of flying wh n made to take flight, would b mistak n by any ne for an auk or grebe ertheless t is essentially petrel, b t w th many parts of ts

the deeply scooped membrane between the toes shows that tru ture has begun to ch nge.

He who belie es in separate and innumerable acts f creation m y say that in these cases it has plea ed th Creato to cause a being of on t pe t take the place f ne belo g ing to an ther type b t *this seems to me* nly re stating th fact in d gnified langu ge He who beli es n th struggl for xistence and in the princ ple of n tural select n will acknowledge th t e ry organ c bein is constantly nd a ouring to n rease in mbers and th t if any one bein v ries r so l ttle e ther hab ts r truct re, and th s g ins an advantage o r some otl er inhabitant f the same country it w ll se n th place f th t

the thrush family bsists by d g— ing ts wings und wate and gra p g to es ith ts feet. All th m mbers of th great order of h men pt rous insects are t rrestrial, xcepting th g l roctotrupes, whi h S r John Lubbock has discovered to be q t in its hab ts t oft nt rs the wat and d es about by th se not f ts l gs but of ts wings, and remains as lo g as f ur h rs be th th surface y t t xh b ts n mod ficat n in structure in accordance with ts ab mal hab ts.

H who beli es that ach bein l as been created as we w see t, m t occas ally fe l t rprise wh h has m t w th an animal ha ing hab ts and tru t re not in agreement. Wh t can be plain than th t the webbed feet of ducks and geese re f rmed f swimming Y t th re are upland geese with ebbed feet hich rarely go n ar th w te and no on cept A d bon has seen th frigate-bird, hich has all ts f ur toe webbed, alight n the surface of th ocean. O th th hand, grebes and coots are min tly aqu tic, although their toes are nly bord red b m m brane. What seem plain than th t th long toes, not f rnished w th m mbran f the Grallatores are f rmed for walking er swamps and floating plants —th w t r hen and landrail are m mbers of this rd y t th first is nearly as *aq atic as th* coot, and th second nearly as t rrestrial as th q l or partridge. In such cases, and many th rs could be g n, hab ts ha changed w th t a corresponding change of truct re Th w bbed feet of th pland goose may be said to have become almost rudimentary in functi n, though not in structure. In the frigate-bird,

birds w th webbed feet, li ing on the d y land and rarely al ght g n the wat that th re sh uld be lo toed corncrak s, *living in* mead ws t ad f n wamp tl t th re should be woodpeck rs where hardly a tree grow th t th re sh uld be di ing thrushes and d ing H men pt ra, and petrels w th the hab ts of auks.

Organs of extreme Perfection and Complication

T suppose th t th ey w th all ts inimitable contri ance f adjusting th focus to d ff nt d tances, f r adm ttin diff t m unt of light and fo th correcti f sph cal and chromat c aberrati co ld hav been f med by natural select seems, I freely confess, abs rd in tl e l ghest d gree When t was first said th t th un tood t ll and the w ld turned ro d th comm n sense of mankind declared the doctr e false but th ld saying *V x popul ox Dei*, as e ry philosopher knows, cann t b tru ted in scie ce Reason t lls me, th t if numero grad ti ns from a simpl and imperfect ye to complex and perfect can be shown *to exist*, *ach grade b ing*

select n, tho gh ins perable by our imagina tion, sh d t be considered as subv rs v of the theory H w a rve comes to be sensitiv to light, hardly concerns us more than how

that we have flying birds and mammals flying insects of the most diversified types and formerly had flying reptiles it is conceivable that flying fish which now glide far through the air slightly rising and turning by the aid of their fluttering fins might have been modified into perfectly winged animals If this had been effected who would have ever imagined that in an early transitional state they had been the inhabitants of the open ocean and had used their incipient organs of flight exclusively as far as we know to escape being devoured by other fish?

When we see any structure highly perfected for any particular habit as the wings of a bird for flight we should bear in mind that animals displaying early transitional grades of the structure will seldom have survived to the present day for they will have been supplanted by their successors which were gradually rendered more perfect through natural selection Furthermore we may conclude that transitional states between structures fitted for very different habits of life will rarely have been developed at an early period in great numbers and under many subordinate forms Thus to return to our imaginary illustration of the flying fish it does not seem probable that fishes capable of true flight would have been developed under many subordinate forms for taking prey of many kinds in many ways on the land and in the water until their organs of flight had come to a high stage of perfection so as to have given them a decided advantage over other animals in the battle for life Hence the chance of discovering species with transitional grades of structure in a fossil condition will always be less from their having existed in lesser numbers than in the case of species with fully developed structures

I will now give two or three instances both of diversified and of changed habits in the individuals of the same species In either case it would be easy for natural selection to adapt the structure of the animal to its changed habits or exclusively to one of its several habits It is however difficult to decide and immaterial for us whether habits generally change first and structure afterwards or whether slight modifications of structure lead to changed habits both probably often occurring almost simultaneously Of cases of changed habits it will suffice merely to allude to that of the many British insects which now feed on exotic plants or exclusively on artificial substances. Of diversified habits innumerable instances could be given I have often watched a tyrant flycatcher (*Saurophagus sulphuratus*) in South America, hovering over one spot and then proceeding to another like a kestrel and at other times standing stationary on the margin of water and then dashing into it like a kingfisher at a fish In our own country the larger titmouse (*Parus major*) may be seen climbing branches almost like a creeper it sometimes like a shrike kills small birds by blows on the head and I have many times seen and heard it hammering the seeds of the yew on a branch and thus breaking them like a nuthatch In North America the black bear was seen by Hearne swimming for hours with widely open mouth thus catching almost like a whale insects in the water

As we sometimes see individuals following habits different from those proper to their species and to the other species of the same genus we might expect that such individuals would occasionally give rise to new species having anomalous habits, and with their structure either slightly or considerably modified from that of their type And such instances occur in nature Can a more striking instance of adaptation be given than that of a woodpecker for climbing trees and seizing insects in the chinks of the bark? Yet in North America there are woodpeckers which feed largely on fruit, and others with elongated wings which chase insects on the wing On the plains of La Plata, where hardly a tree grows there is a woodpecker (*Colaptes campestris*) which has two toes before and two behind a long pointed tongue pointed tail feathers sufficiently stiff to support the bird in a vertical position on a post but not so stiff as in the typical woodpeckers and a straight strong beak The beak however is not so straight or so strong as in the typical woodpeckers but it is strong enough to bore into wood Hence this Colaptes in all the essential parts of its structure is a woodpecker Even in such trifling characters as the colouring the harsh tone of the voice and undulatory flight its close blood relationship to our common woodpecker is plainly declared yet as I can assert not only from my own observation but from those of the accurate Azara in certain large districts it does not climb trees and it makes its nest in holes in banks! In certain other districts however the same woodpecker as Mr Hudson states frequents trees and bores holes in the trunk for its nest I may mention as another illustration of the varied habits of this genus that a

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F ego, the *P ffin ria bera di*, in ts g n ral hab ts, in ts astonishing power f d g in ts mann of swimming a d of flying wh made to take fl ght, w ld be m taken by any e for an uk o a grebe e rtheless it is essen tially a petrel b t w th many parts of ts organisatio prof u dly modified n l t n to ts w hab ts f life wh reas th wood peck f La Pl ta has had its struct re nly lightly modified In th cas f th w ter ouzel, the acut t l server by xam ing its d ad body w ld n h su pected its b-aquat c hab ts y t th s b rd wl ch all ed to the thrush f mily bsists by d g— ing ts wings d r w t r and grasp g st es with ts feet. All the m mbers f th great order f hym pt ro insects are t rrestrial,

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d w h pm t, but d tit te f an th

ious as — —
tio of epid rmic cells, l ing in sa k lik f ld of th skin and th treo bod f med from mbry ni b-c taneous tissu To ar ri h w t j t co lu regard th f rmatio f th th all ts m l lous y t t absol t ly perfect ch ract rs, t is indispensabl th t th reaso h ld co q th maginat b t I h f lt th difficulty far too keenl t b rprised t th rs hes tat ing t t d th p in pl f t al selecti t so tartling l gth.

It is scarcel poss bl t d comp ri g th with t l scope W kn w th t this instrum t has bee perfected b th l g co tin ed ff rts f th h hest h man t l l cts and w t rally inf th t th l as bee f rmed b som wh t an l g process B t m y t this inf re ce b pres mpt Ha an right to assum that th Cre t w ks b int llect al pow rs lik th se f man If m t compare th t an pt cal nstrument ght in m g natio t tak thick la f tran pare t t s. w th pace filled with fl id an l with rv sens t to l ght be th, and th ppose rs p rt f thus la t be co t all hangi l l in d ns t so as to separ t into la rs f dif f re t d ns t and thickn sses, placed t dif f r t distances from ach tl and w th th rfaces of ach la lo ly aangi g f m F rth must ppose that th is pow represe ted b nat ral selectio th rv l f th fittest al inte tl w t hing ach l gl t alt tio tl tran pare t l y rs and caref ll preserv g each wi h d ried circ m tances. w any d ree, tend t prod ce d t t mag W must ppose ach w tat f tl in trum t t be m lt pl ed l th m llı ach t be preserved t l bett prod ced, and tl tl ld ones to be all destro ed In h g bod s, an tio ll se tl l l t alt tio s, g ra t w ll m lt pl tl m alm t finit l and

— ... ... and may t beh that h g ptical instrum t might th be f rm d as perio to of glass, as th w ks f the Creator are to those f man

Modes of Transition

If t could b d m trated that any com pl x organ isted wh h co ld not poss bly f

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ciall if w look t m ch solated species, ro nd

—
nally fo med t a rem t period since wh h ll th m m mbers f the class h e been d loped d in rd to disco e the rly tran tio al grad thro h which th o g n has passed w h uld ha to look to y anc t ance tral f rms, lo g nce becom xt t.

W h ld b xtrem ly ca t ou in con l d g that an rgan co ld n t h e been fo med b tran t al gradat ns f some ki d N m ro case co ld be gi n m gst th l w animals f th sam rgan perf rm g at th sam t m wh ll d tinct fun tions tl s in th l rv f th drag n fly and n th fi h Col tis th l m tary canal re pires, d ests and e cret s. In th Hydra, the an mal m y be t rned in d t, and th te io rface will th d t and th tomach resp re In ch case n t al select n m ht pec l se f any ad antag w re th gained th wh l o p t f an an which had pre iously perf med t f t ns, f f t n al and tl s b inse bl t p greatly chang ts n t re M plants are kn wn wh ch regularly pro d ce t th sam t me diff rently constru ted fl w rs and if ch plants w re t prod ce n ki d l gre t ha g w ld b ffected with comparat dde ess th haract f tl pec es It s, h probabl that tl t sorts f fl w rs b rn by th sam pla t w re riginall diff re tiated by fin ly grad ted t ps, which m y till b f llowed in som f w cases.

Ag tw distinct rgans, o th sam gan und t rv d ff rent f rms, ma sim l taneo l perf rm in th sam ind d al th sam functio and this is an tremely impo tant m ans f trans t to g o instance —tl re are fish with gills b anchiæ th t breath th air dissol ed in the w te t th

life itself originated but I may remark that, as some of the lowest organisms in which nerves cannot be detected are capable of perceiving light it does not seem impossible that certain sensitive elements in their sarcode should become aggregated and developed into nerves endowed with this pecial sensibility

In searching for the gradations through which an organ in any species has been perfected we ought to look exclusively to its lineal progenitors but this is scarcely ever possible and we are forced to look to other species and genera of the same group that is to the collateral descendants from the same parent form in order to see what gradations are possible and for the chance of some gradations having been transmitted in an unaltered or little altered condition But the state of the same organ in distinct classes may incidentally throw light on the steps by which it has been perfected

The simplest organ which can be called an eye consists of an optic nerve surrounded by pigment-cells and covered by translucent skin but without any lens or other refractive body We may however according to M Jourdain descend even a step lower and find aggregates of pigment-cells apparently serving as organs of vision without any nerves and resting merely on sarcodic tissue Eyes of the above simple nature are not capable of distinct vision and serve only to distinguish light from darkness In certain star fishes small depressions in the layer of pigment which surrounds the nerve are filled as described by the author just quoted with transparent gelatinous matter projecting with a convex surface like the cornea in the higher animals He suggests that this serves not to form an image but only to concentrate the luminous rays and render their perception more easy In this concentration of the rays we gain the first and by far the most important step towards the formation of a true picture forming eye for we have only to place the naked extremity of the optic nerve which in some of the lower animals lies deeply buried in the body and in some near the surface at the right distance from the concentrating apparatus and an image will be formed on it

In the great class of the Articulata we may start from an optic nerve simply coated with

contr va [illegible]
the numerous facets on the cornea of their great compound eyes form true lenses, and that the cones include curiously modified nervous filaments But these organs in the Articulata are so much diversified that Müller formerly made three main classes with seven subdivisions besides a fourth main class of aggregated simple eyes

When we reflect on these facts, here given much too briefly with respect to the wide, diversified and graduated range of structure in the eyes of the lower animals and when we bear in mind how small the number of all living forms must be in comparison with those which have become extinct the difficulty ceases to be very great in believing that natural selection may have converted the simple apparatus f an optic nerve coated with pigment and invested by transparent membrane into an optical instrument as perfect as is possessed by any member of the articulate class

He who will go thus far ought not to hesitate to go one step further if he finds on finishing this volume that large bodies of facts, otherwise inexplicable can be explained by the theory of modification through natural selection he ought to admit that a structure even as perfect as an eagle s eye might thus be formed although in this case he does not know the transitional states It has been objected that in order to modify the eye and still preserve it as a perfect instrument many changes would have to be effected simultaneously which it is assumed could not be done through natural selection but as I have attempted to show in my work on the variation of domestic animals it is not necessary to suppose that the modifications were all simultaneous if they were extremely slight and gradual Different kinds of modification would also serve for the same general purpose as Mr Wallace has remarked if a lens has too short or too long a focus it may be amended either by an alteration of curvature or an alteration of density if the curvature be irregular and the rays lo not converge to a point then any increased regularity of curvature will be an improvement So the contraction of the iris and the muscular movements of the eye are neither of them essential to vision but only improvements which might have been added and perfected at any stage of the construction of the instrument Within the highest division of the animal kingdom namely the Vertebrata we can start from an eye so simple that it consists, as in the lancelet, of a little sack of transparent skin furnished with a nerve and

ing instance —
th h rns of tag becom m re and m re branched and the plumes of some bird b com m re finely de l ped as they grow lde Prof Cope tate th t tl teeth f c tain Lizards change m cl m h pe w th advancing y ars w th crustacean n t nly many trivial b t some mportant parts ass m n char act r as recorded by F tz Müll afte ma turity In all ch case —and many co ld be gi n,—if the age fo prod ct o we e retarded th characte f th species, at l ast in ts adult tate, w uld b modified no is t im prol bl that th previo s and earlie tages

can f rm pm but if this has occurred, t is probabl th t th d ff rences between th y ung and th mature and betwee th ma ture and th ld w re primordially acquired by graduated teps.

Spec al Diffi ult es of the Theory f Natu al S lect n

Alth gh w must be trem ly ca ti s in co cl d g th t any gan co ld t h ve been produced by success e, mall tran ti nal grad t ns, y t und btedly se ious cases f difficulty occu

O f th most se io is that f n uter in sects, wh ch are fte d ff re tly constru ted from tl th mal f rt l f mal b t th ase ll b tre ted f th n t ch pt r Th lectri gans of fi hes ff th cas f spec al diff cult f t is mposs bl t con ce by wh t tep th se w drous gans ha bee prod ced B t this not rprising, f d not kn w f wh t use th y are. In tl G m t and t rped tl y no d bt serv a p rf l mea f d f ce and per

that t can hardly be f y se f tl ab p rposes. M reo m th ray b sides tl g t ref rred to, tl re s, as D R. M D

that th re exi t bet ee th gans and

dinary muscl a close analogy in intim te structure in the d tributi n f the n rves, and i the manner in wh ch th y are acted on by a iou re gents. It sho ld also be e pe c ally bserved th t mu cular contract n s ac compan ed b an electr cal discharge and as Dr Radcliffe in ists, in the electrical appar t h t rned d ring re t, the e w uld

but as we an

organs, and as we know noth ng about the hab ts and truct re f the pro nit rs f tl existi g lectric fishes, it would b e tremely bold to maintain that no s rv ceable transi ti re poss bl by which these organs m ht

re w dely r mot m tl ir ffinit s. Wh the sam gan f d in se l members f th sam class especially if in m mbers ha n v ry d ff rent h b ts f life, w m y g er lly attr b te ts prese ce to nh rita ce from a common an t and ts absence in som f th m mbers to loss through dis se o n t al selecti n. So th t, if th electric organs had

th ir mod fied d sce d nts h n l t. But wh n w look t tl bject m l selv w find in th se r l fishes pro ided w tl lectri rgans, th t th are sit ted n diff re t parts f th body —th t tl diff c struct n, as tl ar an m nt f tl p l t s, and according to I cini, n th p ocess or m an b wl ch tl lectri ty is e ted— and lastl n b g pplied w th es proceeding from diff re t urces, and tl I h ps th m t mp rtant f all th diff rences. H nce in th se al fishes f rnished w th lec tr gan th se cann t b co d ed as h m log s, b t nly as analo s in f ti n. C nseq tly th e n aso to pose th t th y h e b n nh rited from a common pro enitor f had th been th case

same time that they breathe free air in their swimbladders this latter organ being divided by highly vascular partitions and having a ductus pneumaticus for the supply of air To give another instance from the vegetable kingdom plants climb by three distinct means by spirally twining by clasping a support with their sensitive tendrils and by the emission of aerial rootlets these three means are usually found in distinct groups but some few species exhibit two of the means or even all three combined in the same individual In all such cases one of the two organs might readily be modified and perfected so as to perform all the work being aided during the progress of modification by the other organ and then this other organ might be modified for some other and quite distinct purpose or be wholly obliterated

The illustration of the swimbladder in fishes is a good one because it shows us clearly the highly important fact that an organ originally constructed for one purpose namely flotation may be converted into one for a widely different purpose namely respiration The swimbladder has also been worked in as an accessory to the auditory organs of certain fishes. All physiologists admit that the swimbladder is homologous or ideally similar in position and structure with the lungs of the higher vertebrate animal hence there is no reason to doubt that the swimbladder has actually been converted into lungs or an organ used exclusively for respiration

According to this view it may be inferred that all vertebrate animals with true lungs are descended by ordinary generation from an ancient and unknown prototype which was furnished with a floating apparatus or swimbladder We can thus as I infer from Owen's interesting description of these parts understand the strange fact that every particle of food and drink which we swallow has to pass over the orifice of the trachea with some risk of falling into the lungs notwithstanding the beautiful contrivance by which the glottis is closed In the higher Vertebrata the branchiæ have wholly disappeared—but in the embryo the slits on the sides of the neck and the loop like course of the arteries still mark their former position But it is conceivable that the now utterly lost branchiæ might have been gradually worked in by natural selection for some distinct purpose for instance Landois has shown that the wings of insects are developed from the tracheæ it is therefore highly probable that in this great class organs which once served for respiration have been actually converted into organs for flight

In considering transitions of organs, it is so important to bear in mind the probability of conversion from one function to another that I will give another instance Pedunculated cirripedes have two minute folds of skin called by

surface of the body and of the sack together with the small frena serving for respiration. The Balanidæ or sessile cirripedes on the other hand have no ovigerous frena the eggs lying loose at the bottom of the sack within the well enclosed shell but they have in the same relative position with the frena large much folded membranes which freely communicate with the circulatory lacunæ of the sack and body and which have been considered by all naturalists to act as branchiæ Now I think no one will dispute that the ovigerous frena in the one family are strictly homologous with the branchiæ of the other family indeed they graduate into each other Therefore it need not be doubted that the two little folds of skin which originally served as ovigerous frena, but which likewise very slightly aided in the act of respiration have been gradually converted by natural selection into branchiæ simply through an increase in their size and the obliteration of their adhesive glands If all pedunculated cirripedes had become extinct and they have suffered far more extinction than have sessile cirripedes who would ever have imagined that the branchiæ in this latter family had originally existed as organs for preventing the ova from being washed out of the sack?

There is another possible mode of transition namely through the acceleration or retardation of the period of reproduction This has lately been insisted on by Prof Cope and others in the United States It is now known that some animals are capable of reproduction at a very early age before they have acquired their perfect character and if this power became thoroughly well developed in a species, it seems probable that the adult stage of development would sooner or later be lost and in this case especially if the larva differed much from the mature form the character of the species would be greatly changed and degraded Again not a few animals after arriving at maturity go on changing in character during nearly their whole lives. With mammals for instance the

details. N w such diff rences are int lligible, and might en ha been expected, n th upposition that pecies belonging to distinct families had slowly becom ad pted t h more and more t of w t and to breath the air F these species, from bel nging to d tinct families, w uld h diff red to cer tai xtent, and in accordance with th prin- ciple that th nature of ach ariation d pends on tw fact rs, viz., th nature f th organism and that of the urrounding conditions, their ariab lit assuredly would t have been exactl th same. Conseq tly natural selec tio w uld ha had diff rent materials ariations t work on, in rd to arri t th sam functional result and th structures thus acq red would alm t ecessaril have dif f red. On th hypothesis of separat acts of creatio th whol case remains unint lligible. This lin of argum t seems t ha had great w ight in leading Fritz M lle to accept th view maintained b m in this lume.

Anoth distinguished zoologist, th lat Professo Clapared has argued in th same manne and has arri ed t th sam result. H show that th re are parasitic mites (Acar idæ belo ing to distinct ub-famil es and families, which are furnished with hair-claspers. These organs must ha been indepe d ntly d loped. as th could not h been in- h rited from common pro enito and in the se ral gro p tl re f rmed b th modifi cation of the fore l gs,—of th hind l gs,—of th maxillæ o lips,—and of ppendages n the und ad of th hind part of th bod

In th f re in cases, w see th sam end gained and th sam functio perf rmed, in beings not t all nl remot l allied, by organ in pparance th gh not in dev lop- ment losel similar On th th hand, t is a commo rul thro gho t nature that th sam end hould be gained. som times in th case of closel related beings, b th most di- ersified means. H w diff rentl constructed is the feath red ng of bird and th m m- brane-co red wing of bat and till more so th four wing of b tterfl th t wing f fl and th tw wings th th l tra of a beetle B al shells are mad to pe and sh t, b t on hat umbe of patterns is th hinge constructed,—from th lo row of neatl interlocki teeth in N cula to th simple ligament of Mussel Seeds are dis- seminated b th ir min t ness,—b their cap- sule being con rted into light balloon-like

n trituous, as —

so as to ttract and be d ured b birds,—by h vin hooks and grapn ls f many kinds and serrated wns, so as to adh re to tl fu of quadrupeds,—and b bein furnished w th wings and pl mes, as diff rent in shape as tl y are l ga t in stru ture so as to be wafted by

ry bree e. I will giv on the instance f r this subject of th sam nd bein gained by the m t div rsified m ans w ll deserves tt tion. Some th rs mai tain that organi be ings hav been f rmed in man w f r the sak of m re variety almost lik to in a sh p b t such a vi w of nature is in redible W th plants having separated sex s, and w th those in which, th ugh hermaphrodit the

poll n grains, wh ch are light and incoh rent, being blown by th wind through m re cl nce to the stigma and thus is th simpl t plan which can w ll be conce ed An almost eq ally simpl th gh ery diff re t, plan occurs in many plants in which mm trical fl we se cretes a f w drop of nectar and is conse quentl sited b insects and these carry the pollen from th anth rs to th stigma.

From this simpl ta w may pass thro h an in xh u tibl numbe f contri ances, all f th sam purpose and ffected in esse tially th sam *mann* b t *entailing chan es in* ery part of th fl w Th nectar may be st red in an ugly shaped receptacles, with th tamens and pistils modified in man w s, som times f rming trap-lik contri ances, and som times capabl f neatly adapted m m ts thro gh irritabilit elasticity From such tru tures w may ad ance till w com t such case f traord nary ad ptation as that lately described by D Cri in th *C y ke* Th orchid has part f ts labell m low l p hollowed o t into a great b ck t into which drop of alm t pure w te contin all fall from tw secreting horns which tand abo t and h n th b ck t is half f ll, th w t rfl w by spo t n o d Th basal part of th labell m tands th buck t, and is tself h llowed o t into a sort f chambe with tw lat ral ntrances within this chambe th re are curious fleshy rid es. The most in enious man, if h had n t w t essed what takes place, could ne ha imagined what purpose all these parts serve.

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body offer under our present state of ignor ance a difficulty almost exactly parallel with that of the electric organs Other similar cases could be given for instance in plants the very curious contrivance of a mass of pollen grains borne on a foot stalk with an adhesive gland is apparently the same in *Orchis* and *Asclepias* —genera almost as remote as is possible amongst flowering plants but here again the parts are not homologous In all cases of beings far removed from each other in the scale of or ganisation which are furnished with similar and peculiar organs it will be found that al though the general appearance and function of the organs may be the same yet fundamental differences between them can always be de tected For instance the eyes of cephalopods or cuttle fish and of vertebrate animals appear wonderfully alike and in such widely sundered groups no part of this resemblance can ...

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back of a darkened chamber Beyond this su perficial resemblance there is hardly any real similarity between the eyes of cuttle fish and vertebrates as may be seen by consulting Hen sen s admirable memoir on these organs in the Cephalopoda It is impossible for me here to enter on details but I may specify a few of the points of difference The crystalline lens in the higher cuttle fish consists of two parts placed one behind the other like two lenses both hav ing a very different structure and disposition to what occurs in the vertebrata The retina is wholly different with an actual inversion of the elemental parts, and with a large nervous ganglion included within the membranes of the eye. The relations of the muscles are as dif ferent as it is possible to conceive and so in other points Hence it is not a little difficult to decide how far even the same terms ought to be employed in describing the eyes of the Ce phalopoda and Vertebrata It is, of course open to any one to deny that the eye in either case could have been developed through the natural selection of successive slight variations but if this be admitted in the one case it is clearly possible in the other and fundamental differences of structure in the visual organs of two groups might have been anticipated in ac cordance with this view of their manner of for mation As two men have sometimes indepen dently hit on the same invention so in the sev eral foregoing cases it appears that natural se lection working for the good of each being and taking advantage of all favourable variations, has produced similar organs as far as function is concerned in distinct organic beings, which owe none of their structure in common to in heritance from a common progenitor

Fritz Müller in order to test the conclusions arrived at in this volume has followed out with much care a nearly similar line of argument. Several families of crustaceans include a few spe cies possessing an air breathing apparatus and fitted to live out of the water In two of these families which were more especially examined by Müller and which are nearly related to each other the species agree most closely in all important characters namely in their sense organs circulating system in the position of the tufts of hair within their complex stomachs, and lastly in the whole structure of the water breathing branchiæ even to the microscopical hooks by which they are cleansed Hence it might have been expected that in the few spe cies belonging to both families which live on the land the equally important air breathing apparatus would have been the same for why should this one apparatus, given for the same purpose have been made to differ whilst all the other important organs were closely similar or rather identical?

Fritz Müller argues that this close similarity in so many points of structure must, in accord ance with the views advanced by me be ac counted for by inheritance from a common progenitor But as the vast majority of the species in the above two families, as well as most other crustaceans are aquatic in their habits it is improbable in the highest degree that their common progenitor should have been adapted for breathing air Müller was thus led carefully to examine the apparatus in the air breathing species and he found it to differ in each in several important points as in the posi tion of the orifices in the manner in which they are opened and closed and in some accessory

tructio of th less well-fitted individuals,—I ha sometime f lt great d fficulty in unde r t tl rigin f rm ti n f pa t f

o as an d n tu m as in the case of th d g th ugh tl e aid in this latte respect m t be l ght f th h re w th hardl a y t l l ll t ll more qu ckly

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look the ffects f tl e d fi st cti n f en geu co d t ns of l fe —of so-c lled spo taneou ariat ns, which seem to d pen l in a qu te bord ate degree tl e n ture f the co d t ns,— f tl t d cy to re rs t l g lo t charact rs,— f tl complex l ws f gro tl ch f correl t n, compensatio of tl e pressure f n part tl &c. —and fi n lly f se ual selecti n by wh ch charact rs f use t se are ft g ined and tl en tra s-mitted m re less perfectl to the othe se th gh of no use t tl sex. B t struct re thus i d ectly gained alt o gh t fir t of n d antage t a pec e, ma bseq entl h been taken ad an t g of by ts mod f ed des-ce da ts, d e cond t ns f life and n ly eq red l al ts

col f ts il st tn co hair f quadrupeds, wh h from be ng corre-lated tl co t t ti al d ff re ce fr m d t rm tl ttacks f sects, m gl t as-suredly be acted l t ral select o The tail of th g aff looks lik an artifi all con tructed fly flap pe and t seem t first in credil le th t this co ld l bee ad pted f ts prese t purp se by ccess l ght mod

Am ca bsol t ly d pe id tl r po r f resisting th ttacks f insects so th t nd d uals l ich co ld t any m ns d f l th m sel from tl ese all m s, w ld b bl t g int past re and thus gai a gre t d ant g It is t that th lar q ad ruped are actually d tro ed (cept n som rare case) b fl es, b t tl are ssantl harassed and tl tre gtl red ced so tl t th y re m re bj ct t disease t so w ll abled in coming d th t se rel f food t sc pe from beasts of prey

Organs now f trif g importance l p ably in som ase bee f l gl mportai ce t an arl prog nit and aft h g been lo l pe fected t f m pe od h bee transm tted t xistin spec arl th sam tat altl gl w l l bt se b t an act all j ri d t ns tl ir truct re w ld of co rse h bee checked by nat al selection. Seeing l w impo tant an gan of locom tio th tail is in most q tic animals, t g ral prese ce and se f m y purpose in so mai land an mals, l ch n tl l g modified w mbladd rs but thei aq t gin, m y pe hap be thus ac co ted f A w ll-d loped tail ha ing been f med in an aquati animal, t might bse-q tly com to be w ked in f all sorts of p rposes,—a fly flappe an rgan of prehen

ad pt ti n to co ce l thus t ee-freq nti bird from ts n m and co sequentl that t was charact f mpo t ce and had been acq red thro gl n ral select n as t is tl e col ur is p obably m l f part d e to sex al select A trailing palm n tl e Malay Archi pel g limbs th l ft t tree by tl aid f quisit ly co tru ted l ook cl t ed around tl nd f the b ancl and tl is contri ance no d bt, is of th h gl est serv ce t tl plant but as w see l mila l ook n many tree whi h are n t limbers, and which, as tl re reaso t b l from the dist but n f th th rn be ng pec es n Af ca and So th Am ri a, ser e as a d f ce agai t browsin q adrupeds, so the pik n tl palm m y t first h been d v l ped f r this ob-ject, and subseq tly l bee mpro d and tak ad ta f b th plant, as t

be, t may possibl be d t the direct ac ti f p trid m tt but w sh ld be ery cautious in drawi g any ch inf ren wh n w see th t th skin on the h ad f the cl an

But Dr Crüger saw crowds of large humble bees visiting the gigantic flowers of this orchid *not in order to suck nectar* but to gnaw off the ridges within the chamber above the bucket in doing this they frequently pushed each other *into the bucket* and their wings being thus wetted they could not fly away but were compelled to crawl out through the passage formed *by the spout or overflow* Dr Crüger saw a continual procession of bees thus crawling out of their involuntary bath The passage is narrow and is roofed over by the column so that a bee in forcing its way out first rubs its back against the viscid stigma and then against the viscid glands of the pollen masses The pollen masses are thus glued to the back of the bee which first happens to crawl out through the passage of a lately expanded flower and are thus carried away Dr Crüger sent me a flower in spirits of wine with a bee which he had killed before it had quite crawled out with a pollen mass still fastened to its back When the bee thus provided flies to another flower or to the same flower a second time and is pushed by its com

to it and the flower is fertilised Now at last we see the full use of every part of the flower of the water secreting horns of the bucket half full of water which prevents the bees from flying away and forces them to crawl out through the spout and rub against the properly placed viscid pollen masses and the viscid stigma

The construction of the flower in another closely allied orchid namely the *Catasetum* is widely different though serving the same end and is equally curious Bees visit these flowers like those of the *Coryanthes* in order to gnaw the labellum in doing this they inevitably

tion to a certain membrane which is instantly ruptured this sets free a spring by which the pollen mass is shot forth like an arrow in the right direction and adheres by its viscid extremity to the back of the bee The pollen mass of the male plant (for the sexes are separate in this orchid) is thus carried to the flower of the female plant where it is brought into contact with the stigma which is viscid enough to break certain elastic threads and retaining the pollen fertilisation is effected

How it may be asked in the foregoing and in innumerable other instances can we understand the graduated scale of complexity and the multifarious means for gaining the same end The answer no doubt is as already remarked that when two forms vary which already differ from each other in some slight degree the variability will not be of the same exact nature and consequently the results obtained through natural selection for the same general purpose will not be the same We should also bear in mind that every highly developed organism has passed through many changes and that each modified structure tends to be inherited so that each modification will not readily be quite lost but may be again and again further altered Hence the structure of each part of each species for whatever purpose it may serve is the sum of many inherited

Finally then although in many cases it is most difficult even to conjecture by what transitions organs have arrived at their present state yet considering how small the proportion of living and known forms is to the extinct and unknown I have been astonished how rarely an organ can be named towards which no transitional grade is known to lead It certainly is true that new organs appearing as if created for some special purpose rarely

saltum We meet with this admission in the writings of almost every experienced naturalist or as Milne Edwards has well expressed it Nature is prodigal in variety but niggard in innovation Why on the theory of Creation should there be so much variety and so little real novelty Why should all the parts and organs of many independent beings each sup

Nature take a sudden leap from structure to structure? On the theory of natural selection we can clearly understand why she should not for natural selection acts only by taking advantage of slight successive variations she can never take a great and sudden leap but must advance by short and sure though slow steps.

Organs of little apparent Importance as affected by Natural Selection

As natural selection acts by life and death — by the survival of the fittest and by the des-

of the wh le class. It scarcely po bl to d cid how m l ll w nce ought to b made f s ch ca ses f hang as th d finit ct f ternal co dit ns, so-called pontaneou ar ı tı s, and tl mpl l ws of g th b t w th these mportar t c pt s we m y con n l g r atur

rem k th t th pe d th t e f th m d pect l l ty th admired bject nd

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f tl Eoce pocl d th g ac f lly sc lp t ed am t f tl Seco d y p od

di tomaceæ w these cre ted th t tl y m ght b mın d and adm ed und th h h po f tl m sc p Th b ty th l tt cas and in many th p p re th wl lly d t y mm try f gro th Fl rs ank am g t th m t b t f l p o d t f t b t tl y h b d red co p in co t ast th th green l and in co seq t th sam tım be t f l, so tl t th y m b easly b rved by sects. I h com to th co cl n f m f d g t an m ar bl rul th t wl n fl w f tl sed b th w nd t l as gaily colo red coroll Se l y l t l b t ally p o d ce t kınd f fl k d pe nd cok red so as t ttract ect th otl closed t col red dest t t f ectar and ted by nsects. H m y on l d th t, if sect had t be d l ped tl face f tl rtl ur plants w uld t ha bee decked th be t f l fl rs, b t w kl h prod ced ly l poo fl as see fi ak, t and ash trees, gra ses, p ach docks, and ttl s, l ch are all fertilised tl ro gl tl y f th wind A similar lin f argum t h lds good w th

fru ts that a rip t awberry o he ry is as pl as g to the y as to th palate —that tl e g ly-coloured f uit f th p ndle wood t ee and the scarl t b rri s f the h lly are b auti f l bject —w ll be admitted by e ery o But s me ely as a gu de to b d be nat as y

re al ys th s d ss min ted wh n embeu u w thin fru t f any kind (th t is w th n a fle hy r pulpy en l pe) if t b coloured f ny br lliant t t, r e d red conspicu us by b ng wh t o black. I w llingly adm t that a

t fl h b e r nd r d b utiful fo o u ty ak but th has been ffected th ugh l select th t is, by the m re be ut ful

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ficulty p nted if w e q r h w t is tl t t in fla d od rs g pl as r nd tl d pl as Hab t in all these cas p pe to l com t a rtain tent t pl y but th re must b som f nd m ntal ca in tl const tut n of the ne us sys tem n each pec es.

N tu al select n ann t possibly p d y modificat n a pe cl s ly f th good f n th pec th gh th gh t t e peci ncessantly tak ad antag f d profits by th tru tur of th s. B t natur l lect can d does It n prod ce tru t f tl d re t injury of th an m ls, as we see in the fang of th ad d and in th vposito f th ichne m n by

feeding male turkey is likewise naked The sutures in the skulls of young mammals have been advanced as a beautiful adaptation for aiding parturition and no doubt they facilitate or may be indispensable for this act but as sutures occur in the skulls of young birds and reptiles which have only to escape from a broken egg we may infer that this structure has arisen from the laws of growth and has been taken advantage of in the parturition of the higher animals

by reflecting on the differences between the breeds of our domesticated animals in different countries —more especially in the less civilised countries where there has been but little methodical selection Animals kept by savages in different countries often have to struggle for their own subsistence and are exposed to a certain extent to natural selection and individuals with slightly different constitutions would succeed best under different climates. With cattle susceptibility to the attacks of flies is correlated with colour as is the liability to be poisoned by certain plants so that even colour would be thus subjected to the action of natural selection Some observers are convinced that a damp climate affects the growth of the hair and that with the hair the horns are correlated Mountain breeds always differ from lowland breeds and a mountainous country would probably affect the hind limbs from exercising them more and possibly even the form of the pelvis and then by the law of homologous variation the front limbs and the head would probably be affected The shape also of the pelvis might affect by pressure the shape of certain parts of the young in the womb The laborious breathing necessary in high regions tends as we have good reason to believe to increase the size of the chest and again correlation would come into play The effects of lessened exercise together with abundant food on the whole organisation is probably still more important and this as H von Nathusius has lately shown in his excellent treatise is apparently one chief cause of the great modification which the breeds of swine have undergone But we are far too ignorant to speculate on the relative importance of the several known and unknown causes of variation and I have made these remarks only to show that, if we are unable to account for the characteristic differences of our several domestic breeds which nevertheless are generally admitted to have arisen through ordinary generation from one or a few parent stocks we ought not to lay too much stress on our ignorance of the precise cause of the slight analogous differences between true species

Utilitarian Doctrine how far true Beauty how acquired

The foregoing remarks lead me to say a few words on the protest lately made by some naturalists against the utilitarian doctrine that every detail of structure has been produced for the good of its possessor They believe that many structures have been created for the sake of beauty to delight man or the Creator (but this latter point is beyond the scope of scientific discussion) or for the sake of mere variety a view already discussed Such doctrines if true would be absolutely fatal to my theory I fully admit that many structures are now of no direct use to their possessors and may never have been of any use to their progenitors but this does not prove that they were formed solely for beauty or variety No doubt the definite action of changed conditions and the various causes of modifications lately specified have all produced an effect probably a great effect independently of any advantage thus gained But a still more important consideration is that the chief part of the organisation of every living creature is due to inheritance and consequently though each being assuredly is well fitted for its place in nature many structures have no no very close and direct relation to present habits of life Thus we can hardly believe that the webbed feet of the upland goose or of the frigate bird are of special use to these birds we cannot believe that the similar bones in the arm of the monkey in the fore leg of the horse in the wing of the bat and in the flipper of the seal are of special use to these animals We may safely attribute these structures to inheritance But webbed feet no doubt were as useful to the progenitor of the upland goose and of the frigate bird as they now are to the most aquatic of living birds So we may believe that the progenitor of the seal did not possess a flipper but a foot with five toes fitted for walking or grasping but we may further venture to believe that the several bones in the limbs of the monkey horse and bat were originally developed on the principle of utility probably through the reduction of more numerous bones in the fin of some ancient fish like progenitor

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all th same to th in xo able princ ple f t ral selecti n. If we adm re the se e al in g iou co tri ances, by which rch ds and many ther plants are fert li ed through insect agen y can w consid r as eq ally perfect the labor tio f d nse l d f poll n by r fir trees, so that f w gran le m y be wafted by chance o to the ovules

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W l sec tl t species d w con d tio f lf ia chang ts l ab ts t m y l l fed l al ts, tl som ry l ke tl se l ts are t co g ers. H ce w can

understand be r ng in mind th t each organ c b ing is trying to li e wh re er it can li e how t has risen that there are upland geese w th w bb d feet, ground woodpeck di ing thru hes, and petr ls w th th h l ts f auks.

Althougl the b l ef tl at a org n so perfect as tl y co ld ha e been f ned by natu al select n, s n gh to stagg r any on v t in th cas of any gan f w kno f a l i g series f grad t n comple ty eacl good fo its possesso the und r cl a gin co d t ns f l f th e is n l g c l mposs b l ty in th acq rement f any co cei able d gree f perfection thro l n tu al select o In th case in wh ch we know f o inte med ate o tran t o al stat we l o ld be e tren ly concl d g tl at n e can l

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W ha e sec tl t in tw b ir s v d ly e m t from l tl e in tl tur l ale r gans serv g f tl same p rpose ar d in x t ru l ppea a l ly m la may l ve been sep t ly a l l p nd ntly f rmed

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select I man tl as mod fi at n are prob bly tl l ect re lt f th l w f n t f growth, d p nd tly of v good h g b tl s g ed B t e n cl tru t re h ft n, as we m y feel as ured bee b q ntly tak ad antage f d t ll f rther modified f th good f pec d n w cond t f l fe We m lso b h that part f m ly f h gh import n

which its eggs are deposited in the living bodies of other insects If it could be proved that any part of the structure of any one species had been formed for the exclusive good of another species it would annihilate my theory for such could not have been produced through natural selection Although many statements may be found in works on natural history to this effect I cannot find even one which seems to me of any weight It is admitted that the rattlesnake has a poison fang for its own defence and for the destruction of its prey but some authors suppose that at the same time it *is furnished with a rattle for its own injury* namely to warn its prey I would almost as soon believe that the cat curls the end of its tail when preparing to spring in order to warn the doomed mouse It is a much more probable view that the rattlesnake uses its rattle the cobra expands its frill and the puff adder swells whilst hissing so loudly and harshly in order to alarm the many birds and beasts which are known to attack even the most venomous species Snakes act on the same principle which makes the hen ruffle her feathers and expand her wings when a dog approaches her chickens but I have not space here to enlarge on the many ways by which animals endeavour to frighten away their enemies

Natural selection will never produce in a

purpose of causing pain or for doing an injury to its possessor If a fair balance be struck be

tions of life if any part comes to be injurious it will be modified or if it be not so the being will become extinct as myriads have become extinct

Natural selection tends only to make each organic being as perfect as or slightly more perfect than the other inhabitants of the same country with which it comes into competition. And we see that this i the standard of perfection attained under nature The endemic productions of New Zealand for instance are perfect one compared with another but they are now rapidly yielding before the advancing legions of plants and animals introduced from Europe Natural selection will not produce absolute perfection nor do we always meet as far as we can judge with this high standard under nature The correction for the aberration of light is said by Müller not to be perfect even in that most perfect organ the human eye Helmholtz whose judgment no one will dispute after describing in the strongest terms the wonderful powers of the human eye adds these remarkable words That which we have discovered in the way of inexactness and imperfection in the optical machine and in the image on the retina is as nothing in comparison with the incongruities which we have just come across in the domain of the sensations. One might say that nature has taken delight in accumulating contradictions in order to remove all foundation from the theory of a pre-existing harmony between the external and internal worlds If our reason leads us to admire with enthusiasm a multitude of inimitable contrivances in nature this same reason tells us though we may easily err on both sides, that some other contrivances are less perfect. Can we consider the sting of the bee as perfect, which when used against many kinds of enemies cannot be withdrawn owing to the backward serratures and thus inevitably causes the death of the insect by tearing out its viscera?

If we look at the sting of the bee as having existed in a remote progenitor as a boring and serrated instrument like that in so many members of the same great order and which has since been modified but not perfected for its present purpose with the poison originally adapted for some other object such as to produce g

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for if on the whole the power of stinging be useful to the social community it will fulfil all the requirements of natural selection though it may cause the death of some few members. If we admire the truly wonderful power of scent by which the males of many insects find their females can we admire the production for this single purpose of thousands of drones which are utterly useless to the community for any other purpose and which are ultimately slaughtered by their industrious and sterile sisters It may be difficult, but we ought to admire the savage instinctive hatred of the queen bee which urges her to destroy the young queens her daughters as soon as they are born or to perish herself in the combat for undoubtedly this is for the good of the community and maternal love or maternal hatred though the latter fortunately is most rare is

all the same to the inexorable principle of natural selection. If we admire the several ingenious contrivances, by which orchids and many other plants are fertilised through insect agency, can we consider as equally perfect the elaboration of dense clouds of pollen by our fir trees, so that a few granules may be wafted by chance on to the ovules?

Summary: the Law of Unity of Type and of the Conditions of Existence embraced by the Theory of Natural Selection

We have in this chapter discussed some of the difficulties and objections which may be urged against the theory. Many of them are serious; but I think that in the discussion light has been thrown on several facts, which on the belief of independent acts of creation are utterly obscure. We have seen that species at any one period are not indefinitely variable, and are not linked together by a multitude of intermediate gradations, partly because the process of natural selection is always very slow, and at any one time acts only on a few forms; and partly because the very process of natural selection implies the continual supplanting and extinction of preceding and intermediate gradations. Closely allied species, now living on a continuous area, must often have been formed when the area was not continuous, and when the conditions of life did not insensibly graduate away from one part to another. When two varieties are formed in two districts of a continuous area, an intermediate variety will often be formed, fitted for an intermediate zone; but from reasons assigned, the intermediate variety will usually exist in lesser numbers than the two forms which it connects; consequently the two latter, during the course of further modification, from existing in greater numbers, will have a great advantage over the less numerous intermediate variety, and will thus generally succeed in supplanting and exterminating it.

We have seen in this chapter how cautious we should be in concluding that the most different habits of life could not graduate into each other; that a bat, for instance, could not have been formed by natural selection from an animal which at first only glided through the air.

We have seen that a species under new conditions of life may change its habits; or it may have diversified habits, with some very unlike those of its nearest congeners. Hence we can understand, bearing in mind that each organic being is trying to live wherever it can live, how it has arisen that there are upland geese with webbed feet, ground woodpeckers, diving thrushes, and petrels with the habits of auks.

Although the belief that an organ so perfect as the eye could have been formed by natural selection, is enough to stagger any one; yet in the case of any organ, if we know of a long series of gradations in complexity, each good for its possessor, then, under changing conditions of life, there is no logical impossibility in the acquirement of any conceivable degree of perfection through natural selection. In the cases in which we know of no intermediate or transitional states, we should be extremely cautious in concluding that none can have existed, for the metamorphoses of many organs show what wonderful changes in function are at least possible. For instance, a swimbladder has apparently been converted into an air breathing lung. The same organ having performed simultaneously very different functions, and then having been in part or in whole specialised for one function; and two distinct organs having performed at the same time the same function, the one having been perfected whilst aided by the other, must often have largely facilitated transitions.

We have seen that in two beings widely remote from each other in the natural scale, organs serving for the same purpose and in external appearance closely similar may have been separately and independently formed; but when such organs are closely examined, essential differences in their structure can almost always be detected; and this naturally follows from the principle of natural selection. On the other hand, the common rule throughout nature is infinite diversity of structure for gaining the same end; and this again naturally follows from the same great principle.

In many cases we are far too ignorant to be enabled to assert that a part or organ is so unimportant for the welfare of a species, that modifications in its structure could not have been slowly accumulated by means of natural selection. In many other cases, modifications are probably the direct result of the law of variation or of growth, independently of any good having been thus gained. But even such structures have often, as we may feel assured, been subsequently taken advantage of, and still further modified, for the good of species under new conditions of life. We may also believe that a part formerly of high importance

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as become of such small importance that it could not in its present state have been acquired by means of natural selection

Natural selection can produce nothing in one species for the exclusive good or injury of another though it may well produce parts or gans and excretions highly useful or even in di pensable or again highly injurious to another species but in all cases at the same time useful to the possessor In each well stocked country natural selection acts through the competition of the inhabitants and consequently leads to success in the battle for life only in accordance with the standard of that particular country Hence the inhabitants of one country generally the smaller one often yield to the inhabitants of another and generally the larger country For in the larger country there will have existed more individuals and more diversified form

selection will not necessarily lead to absolute perfection nor as far as we can judge by our limited faculties can absolute perfection be everywhere predicated

On the theory of natural selection we can clearly understand the full meaning of that old canon in natural history *Natura non facit saltum* This canon if we look to the present inhabitants alone of the world is not strictly correct but if we include all those of past times, whether known or

been formed on two great laws—Unity of Type and the Conditions of Existence By unity of type

of type is explained by unity of descent The expression of conditions of existence so often insisted on by the illustrious Cuvier is fully embraced by the principle of natural selection For natural selection acts by either now adapting the varying parts of each

parts being affected by the direct action of the external conditions of life and subjected in all cases to the several laws of growth and variation Hence in fact the law of the Conditions of Existence is the higher law as it includes through the inheritance of former variations and adaptations that of Unity of Type

CHAPTER VII

MISCELLANEOUS OBJECTIONS TO THE THEORY OF NATURAL SELECTION

I WILL devote this chapter to the consideration of various miscellaneous objections which have been advanced against my views, as some of the previous discussions may thus be made clearer; but it would be useless to discuss all of them, as many have been made by writers who have not taken the trouble to understand the subject. Thus a distinguished German naturalist has asserted that the weakest part of my theory is, that I consider all organic beings as imperfect: what I have really said is, that all are not as perfect as they might have been in relation to their conditions; and this is shown to be the case by so many native forms in many quarters of the world having yielded their places to intruding foreigners. Nor can organic beings, even if they were at any one time perfectly adapted to their conditions of life, have remained so, when their conditions changed, unless they themselves likewise changed; and no one will dispute that the physical conditions of each country, as well as the numbers and kinds of its inhabitants, have undergone many mutations.

A critic has lately insisted, with some parade of mathematical accuracy, that longevity is a great advantage to all species, so that he who believes in natural selection "must arrange his genealogical tree" in such a manner that all the descendants have longer lives than their progenitors! Cannot our critic conceive that a biennial plant or one of the lower animals might range into a cold climate and perish there every winter; and yet, owing to advantages gained through natural selection, survive from year to year by means of its seeds or ova? Mr. E. Ray Lankester has recently discussed this subject, and he concludes, as far as its extreme complexity allows him to form a judgment, that longevity is generally related to the standard of each species in the scale of organisation, as well as to the amount of expenditure in reproduction and in general activity. And these conditions have, it is probable, been largely determined through natural selection.

It has been argued that, as none of the animals and plants of Egypt, of which we know anything, have changed during the last three or four thousand years, so probably have none in any part of the world. But, as Mr. G. H. Lewes has remarked, this line of argument proves too much, for the ancient domestic races figured on the Egyptian monuments, or embalmed, are closely similar or even identical with those now living; yet all naturalists admit that such races have been produced through the modification of their original types. The many animals which have remained unchanged since the commencement of the glacial period, would have been an incomparably stronger case, for these have been exposed to great changes of climate and have migrated over great distances; whereas, in Egypt, during the last several thousand years, the conditions of l [illegible] period would have been of some avail against those who believe in an innate and necessary law of development, but is powerless against the doctrine of natural selection or the survival of the fittest, which implies that when variations or individual differences of a beneficial nature happen to arise, these will be preserved; but this will be effected only under certain favourable circumstances.

The celebrated palæontologist, Bronn, at the close of his German translation of this work, asks, how, on the principle of natural selection, can a variety live side by side with the parent species? If both have become fitted for slightly different habits of life or conditions, they might live together; and if we lay on one side polymorphic species, in which the variability seems to be of a peculiar nature, and all mere temporary variations, such as size, albinism, &c., the more permanent varieties are generally found, as far as I can discover, inhabiting distinct stations,—such as high land or low land, dry or moist districts. Moreover, in the case of animals which wander much about and cross freely, their varieties seem to be generally confined to distinct regions.

Bronn also insists that distinct species never differ from each other in single characters, but in many parts; and he asks, how it always comes that many parts of the organisation should have been modified at the same time through variation and natural selection? But there is no necessity for supposing that all the

parts of any being have been simultaneously modified The most striking modifications, excellently adapted for some purpose might as was formerly remarked be acquired by successive variations if slight first in one part and then in another and as they would be transmitted all together they would appear to us as if they had been simultaneously developed The best answer however to the above objection is afforded by those domestic races which have been modified chiefly through man s power of selection for some special purpose Look at the race and dray horse or at *the greyhound and mastiff Their whole frames* and even their mental characters have been modified but if we could trace each step in the history of their transformation —and the latter steps can be traced —we should not see great and simultaneous change but first one part and then another slightly modified and improved Even when selection has been applied by man to some one character alone — of which our cultivated plants offer the best instances —it will invariably be found that although this one part whether it be the flower fruit or leaves has been greatly changed almost all the other parts have been slightly modified This may be attributed partly to the principle of correlated growth and partly to so-called spontaneous variation

A much more serious objection has been urged by Bronn and recently by Broca namely that many characters appear to be of no service whatever to their possessors and therefore cannot have been influenced through natural selection Bronn adduces the length of the ears and tails in the different species of hares and mice —the complex folds of enamel in the teeth of many animals and a multitude of analogous cases With respect to plants this subject has been discussed by Nageli in an admirable essay He admits that natural selection has effected much but he insists that the families of plants differ chiefly from each other in

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tendency towards progressive and more perfect development. He specifies the arrangement of the cells in the tissues and of the leaves on the axis as cases in which natural selection could not have acted To these may be added the numerical divisions in the parts of the flower the position of the ovule the *shape* of the seed when not of any use for dissemination &c.

There is much force in the above objection. Nevertheless we ought in the first place to be extremely cautious in pretending to decide what structures now are or have formerly been of use to each species In the second place it should always be borne in mind that *when one part is modified so will be other* parts through certain dimly seen causes, such as an increased or diminished flow of nutriment to a part mutual pressure an early developed part affecting one subsequently developed and so forth —as well as through other causes which lead to the many mysterious cases of correlation which we do not in the least understand These agencies may be all grouped together for the sake of brevity under the expression of the laws of growth In the third place we have to allow for the direct and definite action of changed conditions of life and for so-called spontaneous variations, in which the nature of the conditions apparently plays a quite subordinate part Bud variation such as the appearance of a moss rose on a common rose or of a nectarine on a peach tree offer good instances of spontaneous variations but even in these cases if we bear in mind the power of a minute drop of poison in producing complex galls we ought not to feel too sure that the above variations are not the effect of some local change in the nature of the sap due to some change in the conditions There must be some efficient cause for each slight individual difference as well as for more strongly marked variations which occasionally arise and if the unknown cause were to act persistently it is almost certain that all the individuals of the species would be similarly modified

In the earlier editions of this work I underrated as it now seems probable the frequency and importance of modifications due to spontaneous variability But it is impossible to attribute to this cause the innumerable structures which are so well adapted to the habits of life of each species I can no more believe in this than that the well adapted form of a race horse or greyhound which before the principle of selection by man was well understood excited so much surprise in the minds of the older naturalists can thus be explained

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W th respect to plants, t whicl on account of N b s essay I shall confin m self in th following remarks, t w ll be admitted th t th fl ers of rchids prese t a m lt t d of curi ous tructures, which f w ears ago w uld ha been considered mere m rph logical diff rences w tho t an pecial functi b t th y re now kno n t be of th l ghest im

morphic and trim rphi plants th diff re t le gths of the stamens and pistils, and th ir ar rang ment, could h been of an service b t now w know this t be the case

In certain whole gro ps f plants th ules stand rect, and in thers th y are suspended and within the sam arium of som f w plants, one ule h ld th f rm and sec nd ule th latter positio These posit ns seem at first purely morphol gical, o of no ph siological significatio b t D Hook form m th t within th sam arium, th ppe ules alo in som cases, and in th r cases the lo er nes alon are fertilised and h suggests that this probabl depends n th di rection in which th poll n-tubes ent r th arium. If so, th position of th ules, n hen on is rect and the ther uspended with in th same arium, w uld follow from th selection of any l ght d iations in position hich f ured their f rtilisation, and the production of seed.

Se eral plants belo ging to distinct rd rs hal tually produce fl w rs f tw kinds,—the one pe of th rdinary tructure, th ther closed and imperfect. These tw kinds of fl w ers som times diff wond rfully tructure, y t may be see t graduat int ach th on the sam plant. Th ordinary and pen fl rs can be tercrossed and the benefits which cer

tainly are d rived from this process are thus secured. The closed and imperfect flowers are howev r manifestly f h gh mportance as th y y ld with th utmo t saf ty a large tock of seed with the expe diture of w nd rfully little pollen. The two ki ds f fl wers often dif fer m ch, as j t tated, in truct re. The pet als in th imperfect flowers almost alw con sist f mere rudiments, and the pollen grains are red ced in diam te In *Ono col m a* fi of the alt rnate stamens are rud m i tary and in som species of *I ola* three *tam ns are* in this tate, two retainin th proper func tion, but being of ry small size. I six ut f thirt of th cl sed fl wers in an Indian olet (nam unkn wn f r th plants hav ne r produced witl m perfect fl wers) the sepals are red ced from th n rmal numb of fi e to three In e secti n of the Malp ghiaceæ the closed fl w rs, according to A. de J ss u are till furth r modified f r the fi tamen

n t present in th ordinary fl wers f th s pecies th tyl is aborted and the ari are red ced from three to two N w lth gh n t ural selecti n may well ha had th powe to pre nt som of th flow rs f m xpand g, and to red ce the amount f poll n, wh n ren d red b th cl re of the fl w rs sup flu s, yet hardly any of th abo special modifica tions can ha been thus d termined b t must ha f llowed from the law of growth lud ing the funct nal inacti ity f parts, during th progress f th red ti n of th poll n and th clo ure of the fl w rs.

It is so necessary to pprec t the mpo tant ffects f th l w of growth, th t I will gi som add ti nal cases of an ther ki d n m l of diff re ces in th sam part gan d t d ff rences in relati e position on th sam plant. In th Spanish chestn t, d in certain fi trees, th angles f di rg ce of th l es diff according t Sch cht i the nearly h rizo tal a d in th upright bran h s. In the comm ru and som ther plants, o fl w us ally th central t min l n opens first, and has fi sepal and petals, and fi d si ns to th ari m whil t ll the th r fl w rs th plant are t tram rous. In th British Ad the uppermost fl wer g n rally has tw calyx lobes w th th otl gans t tramerous, whilst the urround ng fl w rs generally h ve three calyx lobe w th th oth organs pentam rous. In ma y Composi

tæ and Umbelliferæ (and in some other plants) the circumferential flowers have their corollas much more developed than those of the centre and this seems often connected with the abortion of the reproductive organs It is a more curious fact previously referred to that the achenes or seeds of the circumference and centre sometimes differ greatly in form colour and other characters In *Carthamus* and some other Compositæ the central achenes alone are furnished with a pappus and in *Hyoseris* the same head yields achenes of three different forms In certain Umbelliferæ the exterior seeds according to Tausch are orthospermous and the central one cœlospermous and this is a character which was considered by De Candolle to be in other species of the highest systematic importance Prof Braun mentions a Fumariaceous genus in which the flowers in the lower part of the spike bear oval ribbed one seeded nutlets and in the upper part of the spike lanceolate two valved and two-seeded siliques In these several cases with the exception of that of the well developed ray florets which are of service in making the flowers conspicuous to insects natural selection cannot as far as we can judge have come into play or only in a quite subordinate manner All these modifications follow from the relative position and inter action of the parts and it can hardly be doubted that if all the flowers and leaves on the same plant had been subjected to the same external and internal condition as are the flowers and leaves in certain positions all would have been modified in the same manner

In numerous other cases we find modifications of structure which are considered by botanists to be generally of a highly important nature affecting only some of the flowers on the same plant or occurring on distinct plants which grow close together under the same conditions As these variations seem of no special use to the plants they cannot have been influenced by natural selection Of their cause we are quite ignorant we cannot even attribute them as in the last class of cases to any proximate agency such as relative position I will give only a few instances It is so common to observe on the same plant flowers indifferently tetramerous pentamerous &c that I need not give examples but as numerical variations are comparatively rare when the parts are few I may mention that according to De Candolle the flowers of *Papaver bracteatum* offer either two sepals with four petals (which is the common type with poppies) or three sepals with six petals The manner in which the petals are folded in the bud is in most groups a very constant morphological character but Professor Asa Gray states that with some species of *Mimulus* the æstivation is almost as frequently that of the Rhinanthideæ as of the Antirrhinideæ to which latter tribe the genus belongs Auguste de Saint Hilaire gives the following cases the genus *Zanthoxylon* belongs to a division of the Rutaceæ with a single ovary

the capsule has been described as unilocular or trilocular and in *H mutabile* *Une lame plus ou moins large s'etend entre le pericarpe et le placenta* In the flowers of *Saponaria officinalis* Dr Masters has observed instances of both marginal and free central placentation Lastly Saint Hilaire found towards the southern extreme of the range of *Gomphia oleæformis* two forms which he did not at first doubt were distinct species but he subsequently saw them growing on the same bush and he then add *Voila donc dans un meme individu des loges et un style qui se rattachent tantot a un axe verticale et tantot à un gynobase*

We thus see that with plants many morphological changes may be attributed to the laws of growth and the inter action of parts independently of natural selection But with respect to Nägeli s doctrine of an innate tendency towards perfection or progressive development can it be said in the case of these strongly pronounced variations, that the plants have been caught in the act of progressing towards a higher state of development? On the contrary I should infer from the mere fact of the parts in question differing or varying greatly on the same plant that such modifications

said to raise an organism in the natural scale and in the case of the imperfect, closed flowers above described if any new principle has to be invoked it must be one of retrogression rather than of progression and so it must be with many parasitic and degraded animal We are ignorant of the exciting cause of the above specified modifications but if the unknown cause were to act almost uniformly for a length of time we may infer that the result would be almost uniform and in this case all the indi

viduals f th species w ld be modified in the sam mann

From th fact f th abo e characters being unimportant f th welfare of th spec s, any l ll n ti ns which occ rred in th m wo ld

B t h n, from th nat re f the rganism and f th condit ns, modificat ns ha bee ind ced wh ch are un mpo tant f the w lf re f th spec s, th may be and ppare tly ofte h bee t ansm tted in n ly the sam tate t n m rous, therwise modified, desce dants. It cann t h been of m ch im portance t th gre t numb of mammals, birds, reptil wh th they were l thed w th hai f th s, scal t hair has been

is ft ass med to be f h gh tal mportance t th pec es. Thus, as I am in lined t be- h e, m rph l cal diff re ce wh ch w co sid as important— ch as th rrang m t of th l s, th d isi ns f th fl w f th ari m th po t f th ules, &c.— first ppeared in many case as fl t ting ariat ns, which soo lat becam co ta t thr gh th nat re f th rganism and f th rroundin co d t ons, as w ll as thro h tl int rcrossing f dist ct indi d als, b t t thro gh nat ral selecti f as th ese m rph l g al charact rs d t affect th lfar f tl pec s, y sl ght d ti ns tl m could t ha bee g rned o ac cum l ted thro l th latt gen y It is a trang result which w th arri t, am ly that haract rs f light tal mportance t tl spec es, are th m t impo tant t th ys- temat t b t, as shall l reafte see wh n treat f th g t prin pl f lass fica t n, this is by m ans so parad xical as t ma t first ppear

Alth gh w h good d nce of th ist ce gani be gs f an innat tend enc t ward progress d l pment, y t th ecessarily f ll s, as I h tt mpted t h in tl f urth hapt thro gh th co tin ed actio of nat ral selecti n. F th best

defin stan th tiat e d asm ch as th parts a to perfo m the functions more effic ntly

pa fa ts and cons d at ns oppo ed t his on clus ns, n slight ff t f reason and mem ry is l ft to th read who m y w h to we h th dence n both des. Wh n d sc ssing

der D m t t t gre t l gth than as I b h any th rit r H likew se ft n assumes th t I ttr b t n thing t ar ti n independ tly f tural selecti whereas in th w k y t ref rred to I h collected a gre t numb f w ll-e tabl hed case than can b f und in an th wo k kn wn to me. My j dgm nt may n t be tru tw rthy but aft read n w th care Mr M art book, and compa g ach secti n w th wh t I h e said th sam head I n bef re f lt so tro g ly co ced f th g ral truth f the con cl ns h ar ed t, bject, of co rse, in so int cat bject t m ch p rt al ro

All Mr M art objecti ns will b h been, consid ed in th prese t lum The ne n w po t wh ch ppe rs to h truck many read rs s, th t al select n incompe t t t account f th p ent stag f use- ful tru t res. This bject intim t ly con nected w th th t f th grad ti n f ch c t rs, ft n accompan ed by a chang f f

art select th se wh ch are th m t illus- trat as w t f pac pre nts me from co d g ll.

Th g raff by t l fty stat re m l l n g t d eck, f re-l gs, h ad and to gu has ts

whole frame beautifully adapted for browsing on the higher branches of trees. It can thus obtain food beyond the reach of the other Ungulata or hoofed animals inhabiting the same country; and this must be a great advantage to it during dearths. The Niata cattle in S. America show us how small a difference in

grass, but from the projection of the lower jaw they cannot, during the often recurrent droughts, browse on the twigs of trees, reeds, &c., to which food the common cattle and horses are then driven; so that at these times the Niatas perish, if not fed by their owners. Before coming to Mr. Mivart's objection, it may be well to explain once again how natural selection will act in all ordinary cases. Man has modified some of his animals, without necessarily having attended to special points of structure, by simply preserving and breeding from the fleetest individuals, as with the race-horse and greyhound, or as with the game-cock, by breeding from the victorious birds. So under nature with the nascent giraffe, the individuals which were the highest browsers and were able during dearths to reach even an inch or two above the others, will often have been preserved; for they will have roamed over the whole country in search of food. That the individuals of the same species often differ slightly in the relative lengths of all their parts may be seen in many works of natural history, in which careful measurements are given. These slight proportional differences, due to the laws of growth and variation, are not of the slightest use or importance to most species. But it will have been otherwise with the nascent giraffe, considering its probable habits of life; for those individuals which had some one part or several parts of their bodies rather more elongated than usual, would generally have survived. These will have intercrossed and left offspring, either inheriting the same bodily peculiarities, or with a tendency to vary again in the same manner; whilst the individuals less favoured in the same respects will have been the most liable to perish.

We here see that there is no need to separate single pairs, as man does, when he methodically improves a breed: natural selection will preserve and thus separate all the superior individuals, allowing them freely to intercross, and will destroy all the inferior individuals. By this process long-continued, which exactly corresponds with what I have called unconscious selection by man, combined no doubt in a most important manner with the inherited effects of the increased use of parts, it seems to me almost certain that an ordinary hoofed quadruped might be converted into a giraffe.

To this conclusion Mr. Mivart brings forward two objections. One is that the increased size of the body would obviously require an increased supply of food, and he considers it as very problematical whether the disadvantages thence arising would not, in times of scarcity, more than counterbalance the advantages. But as the giraffe does actually exist in large numbers in S. Africa, and as some of the largest antelopes in the world, taller than an ox, abound there, why should we doubt that, as far as size is concerned, intermediate gradations could formerly have existed there, sub-

other hoofed quadrupeds of the country, would have been of some advantage to the nascent giraffe. Nor must we overlook the fact, that increased bulk would act as a protection against almost all beasts of prey excepting the lion; and against this animal its tall neck,—and the taller the better,—would, as Mr. Chauncey Wright has remarked, serve as a watch-tower.

determined by any one advantage, but by the union of all, great and small.

Mr. Mivart then asks (and this is his second objection), if natural selection be so potent, and if high browsing be so great an advantage, why has not any other hoofed quadruped acquired a long neck and lofty stature, besides the giraffe, and, in a lesser degree, the camel, guanaco, and macrauchenia? Or, again, why has not any member of the group acquired a long proboscis? With respect to S. Africa, which was formerly inhabited by numerous herds of the giraffe, the answer is not difficult, and can best be given by an illustration. In every meadow in England in which trees grow, we see the lower branches trimmed or planed to an exact level by the browsing of the horses or cattle; and what advantage would it be, for instance, to sheep, if kept there, to acquire slightly longer necks? In every district some

on kind of animal will almo.t certainly be able t browse higher than th the and t is almost equally certain that this kind alo e co ld ha ts eck lo gated f th s p rpose thro gh nat ral select n and tl ffects of n creased use In S. Africa th compet t n f bro sing th hi h branches f the acacias and ther trees must be bet een giraffe and giraffe, and not w th the oth r ungulate an mals.

Why in tl r quarters f the w ld ar us animals belo gin to this sam rd ha n t acquired either an lo g ted eck probos cis, cannot be d tm tl ans red b t t is as unreasonable to xpect d t ct an we t s ch q estion, as why som t in th h tory f man d d d n t occur in country whilst t did in anoth r We are n rant w th respect to th cond tions which d termin tl mbe and rang f ach spec es and w cann t e n co ject re what changes f tri t re w ld be f ral t t ncrease some n w co try W can, l see in g al mann that arious causes m gl t h int rf red w th th d lopm t f lo g eck proboscis. T reach th f l ag t co d rabl l gl t (witl out h b f wl ich hoofed animals re g larly l-co istru t d) mpl gre tly n sed b lk f bod and w kn w that som areas pport gula l f w larg q adrupeds, f instance S Am ri a, th gh t is so luxu ia t l lst S Africa abo d w th th m t an parall led d gree Wh tm h ld be so d t kno n l tl lat t tiary period ho ld ha bee so m ch m re f urabl f th st nce than tl prese t tim Wl t th ca se ma ha been, we can see that certain d tricts and tim ld ha bee m ch m re f urabl than th rs f th d lopm t of so large quadruped as tl g raff

I ord that an nimal sh uld acq re som truct re specially and largely d loped t almost nd pensabl that sev ral tl p rts sl ld be mod fied and co-ad pted Altl gl every part f tl bod aries sl ghtl t does not f llo that th ecessary parts sl ld al ary in th ght directio and to th ght d gree W th th d ff re t pec es f o do estic ted ani nals w k w tl t the parts ary in d ff re t mann and d gree and that som speci are m h m re ariable than oth rs. E n d th fitt g ariatio d l arise, t does not f llow that natural selectio would be able to act th m, and prod ce truc ture hich pparе tly w ld be benefi ial t

ch ng t ro i ues —

retarded in mod f g an part cular truc ture f r obtain g food Lastly nat al selec t low process, and th sam fa u ble

w cann t xplain wh in many ju rt s of tl w ld, hoofed quadrupeds l e n t ac

g ing ha been ad anced by ma y w t rs. In each case arı s uses, bes d th ge ral es j t d cated l prob bly i t rf red w th th acq t thro h nat al sel ct n f tru t res, whi h t th ght wo ld be be f al t certain pec es. O e writer asks, wh has n t th o trich equired th pow f fl ght B t a m m t reflection will h w what an rm pply f food w ld be ecessar t gi t this b rd f th desert f ree to m ts h g body through tl air Oceanic i land re inhab ted b b ts and seal b t by t rre trial mammal s t as some of tl ese b ts are peculiar spec s, tl y mu t ha l g inhab ted th ir pre nt l mes. Th ref re S C Ly ll asks, and ass ns certain reasons ans wh h e n t se ls and bats gi n birth cl slands to f rms fitted to l n th land B t seals w uld necessaril be first co rted into terre trial carn ro anim ls f cons d rabl si ard b ts int terrestri l insect ro animals f th f rm tl re w ld be prey f th b ts gro d nsects w l serv as food, but tl w ld already be larg ly pre d n l y th rept les b rds, wh ch fi t colo se and abo d most oce anic lands. G ad t f tru t re w th each tag ben f cial to changi g spec s, w ll be f red l u d certa n pec liar co di ti ns. A ctl t rre trial an mal, by occa si ll h ti g f food n shall w w te

fi d oceanic island th co d t fav able to th gradual recon rsion into a t re trial f rm. B ts, as f rm ly sh wn, prob ably acq red th ir wi gs by t first glidi g thro gl tl air from tree to tree, lik the so

called flying squirrels for the sake of escaping from their enemies or for avoiding falls but when the power of true flight had once been acquired it would never be reconverted back at least for the above purposes into the less efficient power of gliding through the air Bats might indeed like many birds have had their wings greatly reduced in size or completely lost through disuse but in this case it would be necessary that they should first have acquired the power of running quickly on the ground by the aid of their hind legs alone so as to compete with birds or other ground animals and for such a change a bat seems singularly ill fitted These conjectural remarks have been made merely to show that a transition of structure with each step beneficial is a highly complex affair and that there is nothing strange in a transition not having occurred in any particular case

Lastly more than one writer has asked why have some animals had their mental powers more highly developed than others as such development would be advantageous to all? Why have not apes acquired the intellectual powers of man? Various causes could be assigned but as they are conjectural and their relative probability cannot be weighed it would be useless to give them A definite answer to the latter question ought not to be expected seeing that no one can solve the simpler problem why of two races of savages one has risen higher in the scale of civilisation than the other and this apparently implies increased brain power

We will return to Mr Mivart s other objections Insects often resemble for the sake of protection various objects such as green or decayed leaves dead twigs bits of lichen flowers spines excrement of birds and living insects but to this latter point I shall hereafter recur The resemblance is often wonderfully close and is not confined to colour but extends to form and even to the manner in which the insects hold themselves The caterpillars which project motionless like dead twigs from the bushes on which they feed offer an excellent instance of a resemblance of this kind The cases of the imitation of such objects as the excrement of birds are rare and exceptional On this head Mr Mivart remarks As according to Mr Darwin s theory there is a constant tendency to indefinite variation and as the minute incipient variations will be *in all directions* they must tend to neutralise each other and at first to form such unstable modifica-

[illegible] ever build up a sufficiently appreciable resemblance to a leaf bamboo or other object for Natural Selection to seize upon and perpetuate

But in all the foregoing cases the insects in their original state no doubt presented some rude and accidental resemblance to an object commonly found in the stations frequented by them Nor is this at all improbable considering the almost infinite number of surrounding objects and the diversity in form and colour of the hosts of insects which exist As some rude resemblance is necessary for the first start, we can understand how it is that the larger and higher animals do not (with the exception as far as I know of one fish) resemble for the sake of protection special objects but only the surface which commonly surrounds them and this chiefly in colour Assuming that an insect originally happened to resemble in some degree a dead twig or a decayed leaf and that it varied slightly in many ways then all the variations which rendered the insect at all more like any such object and thus favoured its escape would be preserved whilst other variations would be neglected and ultimately lost or if they rendered the insect at all less like the imitated object they would be eliminated There would indeed be force in Mr Mivart s objection if we were to attempt to account for the above resemblances independently of natural selection through mere fluctuating variability but as the case stands there is none

Nor can I see any force in Mr Mivart s difficulty with respect to the last touches of perfection in the mimicry as in the case given by Mr Wallace of a walking stick insect (*Ceroxylus laceratus*) which resembles a stick grown over by a creeping moss or jungermannia So close was this resemblance that a native Dyak maintained that the foliaceous excrescences were really moss Insects are preyed on by birds and other enemies whose sight is probably sharper than ours and every grade in resemblance which aided an insect to escape notice or detection would tend towards its preservation and the more perfect the resemblance so much the better for the insect Considering the nature of the differences between the species in the group which includes the above Ceroxylus there is nothing improbable in this insect having varied in the irregularities on its surface and in these having become more or less green-coloured for in every group the

characters wh ch d ff in the sev ral specie are th m t pt to arv whilst the gen ri charact rs, r those comm t all the peci s, are th most constant.

Tl Greenland whale is e of th most nderful animals in th w ld and th baleen, whal bo e, f ts gre test peculi rities. Th baleen consists f row ach d f th pper j w f abo t 300 pl tes laminæ, l h tand lose tog th tran rsel to th l g ax f th m th. W thin tl main row tl re are som b diary ro s. Th trem t es and inn margins of all th plates are f ed into tiff b istl s, which cl th th hol gigantic palat and serv t train ft th t and tl t sec re th min te pre h h these gre t animals b ist. Th middle and lo gest lamina th Greenland hal is ten, tw l fifteen feet in l gth b t in th d ff re t species f ceta ceans th re re grad t in l gth th mid dle lam na being pecies, according t Scoresb f fect, in an th three, an th ghtee in l es, and th Balæn pt rostrata ly bo t inches in l gth. The q lity of th whale-bo also diff rs in th d f re t peci s.

W th respect t th baleen, Mr Mi art remarks that if t had nce ttained uch a size and d lopm t as to be t all usef l, th n ts presery t and gm tatio w thin se abl l mits w ld be prom ted b t ral sel t alo B t h t btai th begin nin of h sef l d lopm t In an t m be asked, wl y h ld n t th ly prog t rs of th l ales th balee ha possessed mo th co tru ted som thi g lik the lam llated beak f d ck D ks, lik whales, l t b ist g th m d and w t and th fan l has som t m bee called Criblat res, ft rs. I h pe th t I ma n t be misco trued t sa ing th t th pro nit rs f hales did act ally possess m this lam llated l ke tl beak f d k. I wish nl t h w tl t tl not incred l l and that th m m se plat f balee th Gree land whal m l t l bee d loped from h lam llæ l f f grad ted t ps, ach f serv ce to ts pos sso

Tl beak f h ll d k (*Spat l l*) pe is m re be tif l and compl c truc ture than th moutl f l a. Th ppe mandible is furnished ach (in tl pecune xamined b m) with row comb formed of 188 thin, last lam llæ obliq ely be lled so as to be pointed and placed t ansrsely t tl lo ge axis of the m th They

l g t, being about o e th rd of an inch in l gth, and th y project 14 f an inch ben th th edg At th ir bases there i sh rt ub diary row f obliq ly trans rse lam llæ. In these se ral re pects th y resemble the plates f baleen in th m th f a whale But towards the xtrem ty of tl beak th y d ff r much as tl y project inwards, t ad of straight d wnwards. The at re h ad f the sh ll th gh incomparably l ss bulky is abo t o e-e ghteenth of the l gth f th head of mod rat ly larg *Balæn pt a ostrata*, in whi h peci the baleen only nin inch l so that f we w re t make the h ad of th sl ll r as l g as that f the B læ ptera th lam llæ w uld be ix inch in l gth—

equal l gth w th those abo but fin and in bein th furnisl ed it diff rs com p sly from th l r j w f a whale, wh ch is d ti t t f baleen. O th the hand tl extrem ties f these low lam llæ re fra ed int fine b tl points, so that th y th curi ly re semble th plates f balee I th g I ri n a m mbe of th dist t f mil f th petrels, th ppe mand bl al is f rnished w th lam llæ which are w ll d loped and project be e th th margin so that th beak of this b rd resembl in this respect th m th of a whale.

From th h hly d l ped tru ture f th h ll b ak w may proceed (as I ha e l arnt from inf rm tio and spec m ns sent to m b Mr Sal in) w th t any gre t break as far as fitness f fting co cerned thro gh th beak f th *M g etta rm t* and in som respects thro gh th t f tl f *r po* t th beak f th comm d k. In this latt r pe cies th l m llæ re m ch coarse than in th l ll d are firml ttached t th d f th mar d bl th are nly bo t 0 in mbe ach id and d ot project t all ben th tl m rgin Tl are sq re t pped, an l re ed ed w th tran l ce t hard h t ssu as f f rushin food. Th edg f th l w mand l l re rossed b n m rous fin ridg s, wh ch project ry littl Altho h the b ak thus ry inf rio as ift to th t f th sho ll y t this bird, as ery o kn ws,

constantly uses it for this purpose There are other species as I hear from Mr Salvin in which the lamellæ are considerably less developed than in the common duck but I do not know whether they use their beaks for sifting the water

Turning to another group of the same family in the Egyptian goose (Chenalopex) the beak closely resembles that of the common ducks but the lamellæ are not so numerous nor so distinct from each other nor do they project so much inwards yet this goose as I am informed by Mr E Bartlett uses its bill like a duck by throwing the water out at the

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are much coarser than in the common duck almost confluent about 27 in number on each side and terminating upwards in teeth like knobs The palate is also covered with hard rounded knobs The edges of the lower mandible are serrated with teeth much more prominent coarser and sharper than in the duck The common goose does not sift the water but uses its beak exclusively for tearing or cutting herbage for which purpose it is so well fitted that it can crop grass closer than almost any other animal There are other species of geese as I hear from Mr Bartlett in which the lamellæ are less developed than in the common goose

We thus see that a member of the duck family with a beak constructed like that of the common goose and adapted solely for grazing

goose —this into one like the common duck —and lastly into one like the shoveller provided with a beak almost exclusively adapted for sifting the water for this bird could hardly use any part of its beak except the hooked tip for seizing or tearing solid food The beak of a goose as I may add might also be converted by small changes into one provided with prominent recurved teeth like those of the merganser (a member of the same family) serving for the widely different purpose of securing live fish

Returning to the whales the *Hyperoodon bidens* is destitute of true teeth in an efficient condition but its palate is roughened according to Lacepede with small unequal hard points of horn There is, therefore nothing improbable in supposing that some early cetacean form was provided with similar points of horn on the palate but rather more regularly placed and which like the knobs on the beak of the goose aided it in seizing or tearing its food If so it will hardly be denied that the points might have been converted through variation and natural selection into lamellæ as well developed as those of the Egyptian goose in which case they would have been used both for seizing objects and for sifting the water then into lamellæ like those of the domestic duck and so onwards until they became as well constructed as those of the shoveller in which case they would have served exclusively as a sifting apparatus From this stage in which the lamellæ would be two-thirds of the length of the plates of baleen in the *Balænoptera rostrata* gradations which may be observed in still-existing cetaceans lead us onward to the enormous plates of baleen in the Greenland whale Nor is there the least reason to doubt that each step in this scale might have been as serviceable to certain ancient cetaceans with the functions of the parts slowly changing during the progress of development as are the gradations in the beaks of the different existing members of the duck family We should bear in mind that each species of duck is subjected to a severe struggle for existence and that the structure of every part of its frame must be well adapted to its conditions of life

The Pleuronectidæ or flat fish are remarkable for their asymmetrical bodies They rest on one side —in the greater number of species on the left but in some on the right side and occasionally reversed adult specimens occur The lower or resting surface resembles at first sight the ventral surface of an ordinary fish it is of a white colour less developed in many ways than the upper side with the lateral fins often of smaller size But the eyes offer the most remarkable peculiarity for they are both placed on the upper side of the head During early youth however they stand opposite to each other and the whole body is then symmetrical with both sides equally coloured Soon the eye proper to the lower side begins to glide slowly round the head to the upper side but does not pass right through the skull as was formerly thought to be the case It is obvious that unless the lower eye did thus travel round it could not be used by the fish whilst lying in its habitual position on one side The lower eye would also have been liable to be abraded by the sandy bottom That the

common. The ch f ad antages th s gained seem t be protect from th r m s, and facility f feedi g th ground Th diff re t m mbers, h f th f mil present, as Sch dt rema ks, lo sen f f rms x hib ting grad al t ans ti from *Hippoglossus* *p g s* wh h does t in any cons d rable d gree alt the shape in which t lea es th o um to tl soles, wl h are t rely thrown to side.

M M art has tak p th ase and marks that sudd po taneous t ansf rm tio tl no ti f th yes hardly co

far from cl ar It seems, n, that ch an u p ent transf mat m st rall er h been

th h ad cann t l g retai rt cal po tion, g to th cessi depth f tl ir bod es, tl mall iz f th lat al fins, nd to tl be g dest t t f a umbladd H ce soo gro g t red, th y fall t th bott m d Whilst thus at est th y ft n tw t, as M lm observed th l ards, t ser also th m and th y d th so g ro sly th t tl press l l ard gainst th ppe part f tl rb t Tl f reh ad bet ee th es co iseq tl becomes, as o ld be plain- ly seen, t mporaril co t acted breadth. O on occas Malm saw y g fi l ise and d re tl lo thro gl an a gula d s- tance of abo t se t l grees.

W h kl m that th skull t tl is arly ag is rt la ar l flex ble, so that t read l ield to use la action. It also kno w tl tl h gl an mals, ft early y th, that th k ll l and altered in shape if tl sk m scles be pe man tly contracted th l d sease som accid t W th lo g-eared abl ts, if ar lops f l and d ards, ts w ght drag f ward all tl bo es f th k ll on tl same side, of hich I ha gi f gure Malm tates that th ewly l tched g f perch

es,

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o e u

that they ften then train the l w r y so as to look upw rd and tl kulls re thus rend red ratl e rooked Tl e fi l s l w re on l le to h ld th m l es in a e

tl e l ad and n tl e posit f tl es. J dg from logy th t d cy t listort n

s d and th pecies n tl r gl t d Malm

l t th bott m and wims lug ally tl ro gh th w t d in tl fi h th two les f th l ad are said t l so l t d m la O great a th rity o fish s D G tl er o l d his ab tract f Malm s pape b re ark th t th a th g es a ery mpl planation f the bnormal co d t n f th pl ro ecto d

W thus ee th t the first tag f th tran t f th from e d f tl h ad t tl th which Mr M art consid rs w ld b inj s, m y be attrib ted to tl habt n d l t be fi ial to th ind vi l al d to th pec es, f d a rn to look up ards tl both yes, wh lst resting o d t th bot tom W may also attrib t t th nh ted ffects f use th fact f th m th in se l kinds f flat fish b ing be t towards tl l w urf ce, w th th j w bo tro g and m re ffect tl s, th y l s l f tl head, than tl tl f tl sak as Dr Traq pposes, f feedin w th ase tl ground D suse tl th hand will acco t f th less d el ped ond t f th wh l infe half f tl body ncl d th lat ral fins tho gl Y rrel thinks that tl red ced iz f th se fins is ad ant geo t th fish as th is so m ch l ss oom f tl act n, tl w th th larger fins also l hap the l sse n m be f teeth in the proportion f f ur to se n

in the upper halves of the two jaws of the plaice to twenty five to thirty in the lower halves may likewise be accounted for by disuse From the colourless state of the ventral surface of most fishes and of many other animals we may reasonably suppose that the absence of colour in flat fish on the side whether it be the right or left which is undermost is due to the exclusion of light But it cannot be supposed that the peculiar speckled appearance of the upper side of the sole so like the sandy bed of the sea or the power in some species as recently shown by Pouchet of changing their colour in accordance with the surrounding surface or the presence of bony tubercles on the upper side of [illegible]

[illegible] general shape of the body of these fishes and many other peculiarities to their habits of life We should keep in mind as I have before insisted that the inherited effects of the increased use of [illegible]

[illegible] will thus be preserved as will those individuals which inherit in the highest degree the effects of the increased and beneficial use of any part How much to attribute in each particular case to the effects of use and how much to natural selection it seems impossible to decide

I [illegible]

[illegible] monkeys has been converted into a wonderfully perfect prehensile organ and serves as a fifth hand A reviewer who agrees with Mr Mivart in every detail remarks on this structure It is impossible to believe that in any number of ages the first slight incipient tendency to grasp could preserve the lives of the individuals possessing it or favour their chance of having and of rearing offspring But there is no necessity for any such belief Habit and this almost implies that some benefit great or small is thus derived would in all probability suffice for the work Brehm saw the young of an African monkey (Cercopithecus) clinging to the under surface of their mother by their hands and at the same time they [illegible]

[illegible] observed that they curled their tails round the branches of a bush placed in the cage and thus aided themselves in climbing I have received an analogous account from Dr Günther who has seen a mouse thus suspend itself If the harvest mouse had been more strictly arboreal, it would perhaps have had its tail rendered structurally prehensile as is the case with some members of the same order Why Cercopithecus, considering its habits whilst young has not become thus provided it would be difficult to say It is however possible that the long tail of this monkey may be of more service to it as a balancing organ in making its prodigious leaps than as a prehensile organ

The mammary glands are common to the whole class of mammals and are indispensable for their existence they must therefore have been developed at an extremely remote period and we can know nothing positively about their manner of development Mr Mivart asks Is it conceivable that the young of any animal was ever sa[illegible]

[illegible] and of its mother And even if one was so what chance was there of the perpetuation of such a variation But the case is not here put fairly It is admitted by most evolutionists that mammals are descended from a marsupial form and if so the mammary glands will have been at first developed within the marsupial sack In the case of the fish (Hippocampus) the eggs are hatched and the young are reared for a time within a sack of this nature and an American naturalist Mr Lockwood believes from what he has seen of the development of the young that they are nourished by a secretion from the cutaneous glands of the sack Now with the early progenitors of mammals almost before they deserved to be thus designated is it not at least possible that the young might have been similarly nourished And in this case the individuals which secreted a fluid in some degree or manner the most nutritious so as to partake of the nature of milk would in the long run [illegible]

[illegible] glands which are the homologues of the mammary glands would have been improved or rendered more effective It accords with the widely extended principle of specialisation that the glands over a certain space of the sack should have become more highly developed than the remainder and they

would then ha f rmed a breast but at first witho t n ppl as we see n th O nith hyn chus, t the base f the mammalian nes. Thro tain the
in part thro h compensat f growth the ffects f se f nat l selectio
Th d lopm t f th mamm ry gland wo ld l bee f n serv ce, and co ld not h e bee ffected through n tural select n, unl ss the y ung t the sam tim w re able to partak f th secret There is greater d fficulty in und tand g how y ng m m mal ha instincti ely lear t to s ck the breast, than in under tanding h w unhatched ch k ns l a e lear t t break the egg h ll by tapp g ainst it w th th ir pecially ad pted

m th f h h lpl ss, h lf f med off p ing O th head M M art remarks D d no pecial p isi e ist, th y un e m t n fall bly b h ked by the intru io f th m lk t th indp pe B t th re is special pro- Th larynx is so l g ted th t t rises p to th post e d f the nasal passag and is th nabled t g free t ce t th ai f tl l gs, hil th m lk passe h rm lessl ach id f th lo g ted larynx and so saf ly attain the gull t b l ind t. M M art th asks h w did t al select re- m th ad lt kang roo (d most th r mammals th ass mpt tl t tl y ar d sce ded from a m rs p al f m) th t least perfectl nnocent and harml ss tr t *t* It may be gg t d ans th t th ce l h is certai ly f h gh *impo tance to many* an mals, uld l rdly l e bee used th f ll f rce as lo g as tl larv t red th nasal passag d I rof sso Flo has suggested t th t th tri t re ld h gre tly in terf red th an ai mal ll ing solid food
W ll w t m f sl rt pace t th lo d ions of th an mal kingd m Th Ech d mata (tar f sh s, se rch ns, &c.) are f rn hed w th remarkabl gans, called pedicellariæ hich consi t, wl w ll d l oped, of t idactyl f rceps—th t is, f ne

f rmed of three se r ted arms, n atly fitt g tog the and placed o the ummit of a fle ble t m moved by muscles Th s forceps c n firmly seize h ld f any bject and Alex d Agassi has s en an Echinu o s urchin r p dly pass g particl s of e rement from forcep to forceps down ce tain l of ts body in rd th t ts hell ho ld n t be f led But there is no d ubt th t b de re m vi d rt f all kinds, they ub er other funct ons a d o of th s apparently d f

g n g f ch st tur s, and h w co ld

tr dactyle forc pses, immo ably fixed t the base, but capabl f a snapping acti n, ce ta n ly exist n som tarfish s and thi intelli g bl if th y serve at l ast in part, as m ans of defence M Agassiz to wh se g t k d n ss I m d bted f m ch inf mat n n the subject nf rm me that there r th r tar fi h s, in wh ch o e of the thre arm f

th h ll i desc bed by M. Perrie as bearing two ki d f ped ell riæ n resembli g th se f Ech us, and th th those f Spatangus and ch case re alw y t restin as fford ing th m ans f ppare tly udde t ansi t s, thro gh tl e abort on of n of th two *tat f an gan*
W th respect to th step by which th se curi rgan h b e ol ed Mr Agassiz nfers from l wn arch s and th se f Müll th t b tl n ta fi h and a u hins the ped cellar æ must und btedly b look d t as modified pines This m y b inf red from th mann f d l pm t in the i d d l as ll as f m a l g and perfect series

extend even to the manner in which ordinary spines and pedicellariæ with their supporting calcareous rods are articulated to the shell In certain gene a of star fishes the very com binations *needed to show that the pedicellariæ* are only modified branching spines may be found Thus we have fixed spines with three equi-distant, serrated moveable branches ar ticulated to near their bases and higher up on the same spine three *other* moveable branches Now when the latter arise from the summit of a spine they form in fact a rude tri dactyle pedicellaria and such may be seen on the same spine together with the three lower branches In this case the identity in nature between the arms of the pedicellariæ and the moveable branches of a spine is unmistakable It is generally admitted that the ordinary spines serve as a protection and if so there can be no reason to doubt that those furnished with serrated and moveable branches likewise serve for the same purpo e and they would thus serve still more effectively as soon as by meeting together they acted as a prehensile or snapping apparatus Thus every gradation from an ordinary fixed spine to a fixed pedicel laria would be of service

In certain genera of star fishes these organs instead of being fixed or borne on an immove able support are placed on the summit of a flexible and muscular though short, stem and in this case they probably subserve some addi tional function besides defence In the sea urchins the steps can be followed by which a fixed spine becomes articulated to the shell and is thus rendered moveable I wish I had space here to give a fuller abstract of Mr Agassiz s interesting observations on the de velopment of the pedicellariæ All possible gra dations as he adds may likewise be found be tween the pedicellariæ of the star fi hes and the hooks of the ophiurians another group of Echinodermata and again between the pedi cellariæ of sea urchins and the anchors of the Holothuriæ also belonging to the same great class

ferent species. In their most perfect condition they curiously resemble the head and beak of a vulture in miniature seated on a neck and ca pable of movement, as is likewise the lower jaw or mandible In one species observed by me all the avicularia on the same branch often moved simultaneously backwards and for wards with the lower jaw widely open through an angle of about 90 in the course of five sec onds and their movement caused the whole polyzoary to tremble When the jaws are touched with a needle they seize it so firmly that the branch can thus be haken

Mr Mivart adduces this case chiefly on ac*count of the supposed difficulty of organs,* namely the avicularia of the Polyzoa and the pedicellariæ of the Echinodermata, which he

as far as structure is concerned I can see no similarity between tridactyle pedicellariæ and avicularia. The latter resemble somewhat more closely the chelæ or pincers of crustaceans and Mr Mivart might have adduced with equal appropriateness this resemblance as a special difficulty or even their resemblance to the head and beak of a bird The avicularia are believed by Mr Busk Dr Smitt, and Dr Nitsche—naturalists who have carefully stud-

between a zooid and an avicularium. It is therefore impossible to conjecture by what serviceable gradations the one could have been converted into the other but it by no means follows from this that such gradations have not existed

As the chelæ of crustaceans resemble in some degree the avicularia of Polyzoa, both serving as pincers, it may be worth while to show that with the former a long series of serv iceable gradations still exists In the first and simplest stage the terminal segment of a limb shuts down either on the square summit of the broad penultimate segment, or against one whole side and is thus enabled to catch hold of an object but the limb still serves as an or gan of locomotion We next find one corner of the broad penultimate segment slightly prom inent, sometimes furnished with irregular teeth and against these the terminal segment shuts down By an increase in the size of this projec tion with its shape as well as that of the ter minal segment slightly modified and improved, the pincers are rendered more and more per fect until we have at last an instrument as ef

forceps as the chelæ of a lobster; and all these gradations can be actuall traced.

Besides the viecularia, the Polyzoa possess curious organs called vibracula. These gener a consist of long bristles, capable of movement and easily excited. In one species examined by me the vibracula were slightl curved and serrated along the out margin and all of them on the same polyzoary oft n moved simultaneousl so that, acting lik lon oars, the swept branch rapidly across the object glass of m microscope. When a branch was placed on its face the ibracula becam entangled, and the made violent efforts to free themselves. The are supposed t serv as def nce and ma be seen, as M B sk remarks, "to sweep slo ly and careful the surface of the polyzoary remo ing what might be no ous to the d licate inhabitants of the cells hen their tentacula are protruded." The vicularia, lik the ibracula, probably serv for defence but they also catch and kill small li ing animals, hich t is belie ed are after ard swept b the currents within reach of the tentacula of the zooids. Som species are provided with vicularia and vibracula some th vicularia alone and a few w th vibracula alone.

It is not ea to imagine two objects more widel different in appearance than a bristle or vibraculum, and an vicularium lik the head of a bird yet they are almost certaml homologous and ha been dev loped from the same common source namel zooid with its cell. Hence w can understand how t is that these organs gradua in some cases, as I am informed b M Busk, int each other Thus th the vicularia of se eral pecies of Lepralia, the moveable mandible is so much produced and is so like b istle that the presence of the upper or fixed beak alone serves to determine even its vicularian nature. Th vibracula may ha been directl d loped from the lips of the cells, witho t ha ing passed through the vicularian stage but t seems more probable that the ha passed through this stage, as during the arly stages of the transformation, the other parts of the cell with the included zooid could hardl ha disappeared t once In many cases the vibracula ha e grooved support at the base which seems to represent the fixed beak though this pa t in some species is quit absent. This iew of the development of the ibracula, if trus orthy is interesting for supposin that all the species pro ided with vicularia had become extinct, no one with the most vivid imagination would ver have thought that th vibracula had originall xisted as part of an organ, resemblin a bird's head or an irregular box or hood. It is interesting to see two such widely different organs developed from a common origin and as the mo eable lip of th cell serves as a protection to the zooid, there is no difficulty in belie ing that all the gradations, by which the lip becam converted first into th lower mandib of an vicularium and th n int an lo gated bristle likewise served as a protection in dif rent w s and under different circum tances.

In the vegetable kingdom Mr Mivart only alludes to two cases, namely the structure of the flow rs of orchids, and the mo ments of climbing plants. W th respect to the former he says, "Th explanation of their *origin* is deemed thoroughl unsatisfactory— tterly insufficient t xplain the incipient, infinitesimal beginnings of structures which are of utility only when they are considerabl d eloped." As I have fully treated this sub ect in another work, I will here gi e only a f w d tails on one alone of the most strikin peculiarities of the flowers of orchids, namel their pollinia. A pollini m when highl de eloped consists of a mass of pollen-grains, affixed to an elastic foot stalk or caudicle, and this to a little mass of extrem l viscid matter Th pollinia are by this means transported by insects from one flower to th tigma of another In some or chid there is no caudicle to the pollen masses, and the grains are merel tied together b fine threads but as these are not confined to or chids, the need not here be considered y t I ma mention that t the base of the orchidaceous series, in *Cypripedium*, w can see h w the threads were probabl first developed. In other orchids the threads coh re t one end of the pollen-masses and this forms the first or nascent trace of a caudicle. That this is the origin of th caudicle even when of considerable length and highly d loped, w ha e good evidence in the aborted pollen-grains which can sometimes be detected mbedded within the central and solid parts.

W th respect to the second chief peculiarity namel the little mass of viscid matter attached to the nd of the caudicle, a lon series of gradations can be specified, each of plain service to the plant. In most flowers belonging t other orders the stigma secretes little viscid matter N w in certain orchids similar vis-

cid matter is secreted, but in much larger quantities by one alone of the three stigmas; and this stigma, perhaps in consequence of the copious secretion, is rendered sterile. When an insect visits a flower of this kind, it rubs off some of the viscid matter, and thus at the same time drags away some of the pollen-grains. From this simple condition, which differs but little from that of a multitude of common flowers, there are endless gradations,—to species in which the pollen-mass terminates in a very short, free caudicle,—to others in which the caudicle becomes firmly attached to the viscid matter, with the sterile stigma itself much modified. In this latter case we have a pollinium in its most highly developed and perfect condition. He who will carefully examine the flowers of orchids for himself will not deny the existence of the above series of gradations—from a mass of pollen-grains merely tied together by threads, with the stigma differing but little from that of an ordinary flower, to a highly complex pollinium, admirably adapted for transportal by insects; nor will he deny that all the gradations in the several species are admirably adapted in relation to the general structure of each flower for its fertilisation by different insects. In this, and in almost every other case, the enquiry may be pushed further backwards; and it may be asked how did the stigma of an ordinary flower become viscid, but as we do not know the full history of any one group of beings, it is as useless to ask, as it is hopeless to attempt answering, such questions.

We will now turn to climbing plants. These

provided with tendrils. In these two latter classes the stems have generally, but not always, lost the power of twining, though they retain the power of revolving, which the tendrils likewise possess. The gradations from leaf-climbers to tendril-bearers are wonderfully close, and certain plants may be indifferently placed in either class. But in ascending the series from simple twiners to leaf-climbers, an important quality is added, namely sensitiveness to a touch, by which means the foot-stalks of the leaves or flowers, or these modified and converted into tendrils, are excited to bend round and clasp the touching object. He who will read my memoir on these plants will, I think, admit that all the many gradations in function and structure between simple twiners and tendril-bearers are in each case beneficial in a high degree to the species. For instance, it is clearly a great advantage to a twining plant to become a leaf-climber; and it is probable that every twiner which possessed leaves with long foot-stalks would have been developed into a leaf-climber, if the foot-stalks had possessed in any slight degree the requisite sensitiveness to a touch.

As twining is the simplest means of ascending a support, and forms the basis of our series, it may naturally be asked how did plants acquire this power in an incipient degree, afterwards to be improved and increased through natural selection. The power of twining depends, firstly, on the stems whilst young being extremely flexible (but this is a character common to many plants which are not climbers); and, secondly, on their continually bending to all points of the compass, one after the other in succession in the same order. By this movement the stems are inclined to all sides, and are made to move round and round. As soon as the lower part of a stem strikes against any object and is stopped, the upper part still goes on bending and revolving, and thus necessarily twines round and up the support. The revolving movement ceases after the early growth of each shoot. As in many widely separated families of plants, single species and single genera possess the power of revolving, and have thus become twiners, they must have independently acquired it, and cannot have inherited it from

common with plants which did not climb, and that this had afforded the basis for natural selection to work on and improve. When I made this prediction, I knew of only one imperfect case, namely, of the young flower-peduncles of a *Maurandia* which revolved slightly and irregularly, like the stems of twining plants, but without making any use of this habit. Soon afterwards Fritz Müller discovered that the young stems of an *Alisma* and of a *Linum*,—plants which do not climb and are widely separated in the natural system,—revolved plainly, though irregularly; and he states that he has reason to suspect that this occurs with some other plants. These slight movements appear to be of no service to the plants in question; anyhow, they are not of the least use in the way of climbing, which is the point that concerns us. Nevertheless we can see that if the stems of these plants had been flexible, and

f nde the co d tio to which they are ex

t l sed tl ro gh nat ral select o u had becom co rted into w ll-de l ped twi g pec s.

W tl respect to the sensit n ss of the foot-talks f th l e and fl w and f te drils, arly tl e same rem ks are ppl cabl as n th ase f tl e l g m m ts f tw g plants. As ast mb of pec s, b l g to wid ly dist ct groups, re d ed th tl kind f sens t ss, t gl t t be f nd asce t co d t many pl ts hich h t becom limb rs Th s the case I bserved tl t th y g fl w pedun les f tl e ab M d rved th msel l ttle t ward th de wh b as to l ed M rre f d se al spec s f O al th t

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g shak and with l mb g plants t s, as kn w ly d ring th arly tag s f gro th that th foot talks and t drils re sensit

It scarcel possibl tl t th bo l gl t mo m ts, d to t ch l ak th y ung and growing rg ns f pla ts ca b f an f t al mportan e t th m B t plants possess, bed ce to n us t n h, pow f mo ment, wh h are f manifest mpo tance to th m f nsta ce to ard and m e ar l from th l gl t.— pposition to, and more arel th d rectio f tl tt act n of gr t W tl rves and m scles f an an ial are ted by gal ani m by th ab-sorpt f try t th conseq t m e-m ts m y be called an incid tal res lt, f the rves and muscles h not been re d ed specially sen ti to these tim h. So w th plants t ppears that, from ha ing th pow of m m t obed ence to certai timuli, they are cited in an cid tal mann by touc b be g shak n. H nce th re is n gre t d fficulty admitti g that in th case of leaf-climbers and tendril bearers, t is this

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elect ncomp te t t ac unt f r tl in p t tag of usef l tru t es and I h ve h wn, as I h pe that th re no gre t d ffi ulty th l ad A good pportun ty has th been fforded f r e l gi g a littl g d t s f stru t re ften associ ted with b g d f tion — n mp rta t bject wh ch was n t tr ted t ffi nt l gth in tl f rm ed t o f th w k I will now b fly capt lat the f g ing cases.

W th th giraff tl co ti ued pre rvation f th d d ls f som t t h gh each g ruminant, wh cl had th l ngest necks, legs, &c. and co ld browse l ttl b e the a ag b ght, and th ti ed d truct n f th wl ch co ld n t b wse so h gh w uld h fficed f tl p od ct n f th re markabl q adruped b t tl prol ged se f all th parts tog tl r w th inh ritance w ll ha aided an impo tant m n r in th r co-ordinati n. W th th many insects wh ch m t t n bjects, th re is no mp ba-b lity in th b l f that an acc d tal resem blance to som comm bject was ach case th f und t f the w k f natu al selecti since pe fected thro gh the occas n al preser tion of light n t ns which m de th resemblance t all close and thus will h been carried as l g as th insect con tin ed to ary and as lo g as m re and m perfect resemblance led to its escape from

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W th respect to th sensiti ness f the foot talks of th l es and fl w rs, and f t ndrils, n arly the sam rem ks are ppl cabl as in th ase of th re lving m m ts f twi g plants. As ast umbe of spec es, bel g ing to wid ly distin t gro ps, are d wed w th this kind f sens ti ess, t ght t be f und nasce t co dit n many plants bicl ha t becom limbers. Th the case I observed th t the ung fl w r ped les of th abo M ra d rved th mselves little t ward th sid wh ch was t hed M rre f nd se ral pecies f O al that th l and th ir foot talk m ed pe ciall aft xpos re t h t un, wh n th y w re g tl and repe tedly t ched, when th plant was shak n. I repeated th se obse t ns som th pec es f O al w th th sam result in som f th m th m e-

t ndency wh ch has been tak n advantage of and increased through natural select on It is, h w e probabl from reason wh ch I ha e as gned n my m m ir that th s will h oc urred ly with plants wh ch had already ac quired the pow r f re ol ing, and had thus becom twin rs.

I ha already d v ured to xpla n how plants becam twin rs, am ly by the rease f a t nd cy to l ght and regular re l ing m m ts, which w re t first f no se t th m thus m me t, as w ll as that d t a t u h hak b ing the ncide tal re lt f th po f mo ing gained f r oth r and be fi al purposes. Wheth during the gradual d v lopm t f climb g plants, n t ral select on h been aided by th inhe ted ffects f use I w ll n t prete d t decide b t w kn w th t certain period cal m vem nts f in tance th so-called leep f plants, are g rned by hab t

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hoots and lea f all plants m aft be ng shak and th climbing plants t is, as know ly d ring th early stag s f gro th that th foot talks and t drils are sensit

It is scarcely possibl that th abo l ght mo m ts, d to t ch shak in th ou g and growing rgans f pla ts, can be f any f t nal importa ce t th m B t plants possess, in bed ce to arious t m li, pow rs of mo m t, hich are of mai fest mpo tance to th m f nstance t wards and m re rar l from th l gl t,— ppos tio to, and m re rarel in th d rectio f th ttracti of gra t Wl th rves and m scles f an animal are ted b gal anism by th ab- sorption f try hnin th conseq t m e- me ts ma be called an incid tal result, f the rves and m scles ha not been rend red specially sensit to these timuli. So w th plant t ppears that, from ha ing th pow of m ment in obed ence to certain timuli, they are cited in an incid tal mann by touch, or b being shak n. H nce th re is n great difficulty in admitting that in the case of leaf-climbers and tendril-bearers, t is this

d tions of tru ture ften associ ted w th ha ged f t ns — mp t nt subject wh h was not treated t uffic t l gth in th f mer ed tions f thi w k. I will n w b fl recap t lat th f reg ing cases.

W th th g raff the co tin ed preservs t n f th ind d als f som xtin t h gh reach ing ruminant, h ch had the lo est necks, l gs, &c., and could browse a littl b th era h ght, and th co tin ed destru t n f th se whi h could n t browse so h gh w uld h fficed f th prod tion f this re markabl quadruped b t tl prolo ged use f all th parts tog th with inh ritance w ll h aided in an mportant mann in th ir co-ordinati n. W th th many insects which m t te arious objects, th re is no mprob b lity in th beli f that an accid tal resem blance to som comm n bject was in ach case th found t n f th wo k f nat ral selectio since perfected thro gh th occas al preserv tion of slight riat ns which mad th resemblance t all clos and thus will ha been carried as l g as the insect con tin ed to ary and as lo g as a m re and m re perfect resemblance led to ts escape from

sharp sighted enemies In certain species of whales there is a tendency to the formation of irregular little points of horn on the palate and it seems to be quite within the scope of natural selection to preserve all favourable variations, until the points were converted first into lamellated knobs or teeth like those on the beak of a goose —then into short lamellæ like those of the domestic ducks —and then into lamellæ, as perfect as those of the shoveller-duck —and finally into the gigantic plates of baleen, as in the mouth of the Greenland whale In the family of the ducks the lamellæ are first used as teeth then partly as teeth and partly as a sifting apparatus and at last almost exclusively for this latter purpose

With such structures as the above lamellæ of horn or whalebone habit or use can have done little or nothing as far as we can judge towards their development On the other hand the transportal of the lower eye of a flat fish to the upper side of the head and the formation of a prehensile tail may be attributed almost wholly to continued use together with inheritance With respect to [illegible]

[illegible] a nutritious fluid and that these glands were improved in function through natural selection and concentrated into a confined area in which case they would have formed a mamma There is no more difficulty in understanding how the branched spines of some ancient echinoderm which served as a defence became developed through natural selection into tridactyle pedicellariæ than in understanding the development of th [illegible]

[illegible] for locomotion In the avicularia and vibracula of the Polyzoa we have organs widely different in appearance developed from the same source and with the vibracula we can understand how the successive gradations might have been of service With the pollinia of orchids the threads which originally served to tie together the pollen grains can be traced cohering into caudicles and the steps can likewise be followed by which viscid matter such as that secreted by the stigmas of ordinary flowers and still subserving nearly but not quite the same purpose, became attached to the free ends of the caudicles —all these gradations being of manifest benefit to the plants in question

With respect to climbing plants, I need not repeat what has been so lately said

It has often been asked if natural selection be so potent, why has not this or that structure been gained by certain species, to which it would apparently have been advantageous But it is unreasonable to expect a precise answer to such questions, considering our ignorance of the past history of each species, and of the conditions which at the present day determine its numbers and range In most cases only general reasons but in some few cases special reasons can be assigned Thus to adapt a species to new habits of life many co-ordinated modifications are almost indispensable and it may often have happened that the requisite parts did not vary in the right manner or to the right degree Many species must have been prevented from increasing in numbers through destructive agencies which stood in no relation to certain structures, which we imagine would have been gained through natural selection from appearing to us advantageous to the species In this case as the struggle for life did not depend on such structures they could not have been acquired through natural selection In many cases complex and long-enduring conditions often of a peculiar nature are necessary for the development of a structure and the requisite conditions may seldom have concurred The belief that any given structure which we think often erroneously would have been beneficial to a species would have been gained under all circumstances through natural selection is opposed to what we can understand of its manner of action Mr Mivart does not deny that natural selection has effected something but he considers it as demonstrably insufficient to account for the phenomena which I explain by its agency His chief arguments have now been considered and the others will hereafter be considered They seem to me to partake little of the character of demonstration and to have little weight in comparison with those in favour of the power of natural selection aided by the other agencies often specified I am bound to add that some of the facts and arguments here used by me have been advanced for the same purpose in an able article lately published in the *Medico-Chirurgical Review*

At the present day almost all naturalists admit evolution under some form Mr Mivart believes that species change through an internal force or tendency about which it is not pretended that anything is known That

species have a capacity for change will be admitted by all evolutionists; but there is no need, as it seems to me, to invoke any internal force beyond the tendency to ordinary variability, which through the aid of selection by man has given rise to many well-adapted domestic races, and which through the aid of natural selection would equally well give rise by graduated steps to natural races or species. The final result will generally have been, as already explained, an advance, but in some few cases a retrogression, in organisation.

Mr. Mivart is further inclined to believe, and some naturalists agree with him, that new species manifest themselves "with suddenness and by modifications appearing at once." For instance, he supposes that the differences between the extinct three-toed Hipparion and the horse arose suddenly. He thinks it difficult to believe that the wing of a bird "was developed in any other way than by a comparatively sudden modification of a marked and important kind"; and apparently he would extend the same view to the wings of bats and pterodactyles. This conclusion, which implies great breaks or discontinuity in the series, appears to me improbable in the highest degree.

Every one who believes in slow and gradual evolution, will of course admit that specific changes may have been as abrupt and as great as any single variation which we meet with under nature, or even under domestication. But as species are more variable when domesticated or cultivated than under their natural conditions, it is not probable that such great and abrupt variations have often occurred under nature, as are known occasionally to arise under domestication. Of these latter variations several may be attributed to reversion; and the characters which thus reappear were, it is probable, in many cases at first gained in a gradual manner. A still greater number must be called monstrosities, such as six-fingered men, porcupine men, Ancon sheep, Niata cattle, &c.; and as they are widely different in character from natural species, they throw very little light on our subject. Excluding such cases of abrupt variations, the few which remain would at best constitute, if found in a state of nature, doubtful species, closely related to their parental types.

My reasons for doubting whether natural species have changed as abruptly as have occasionally domestic races, and for entirely disbelieving that they have changed in the wonderful manner indicated by Mr. Mivart, are as follows. According to our experience, abrupt and strongly marked variations occur in our domesticated productions, singly and at rather long intervals of time. If such occurred under nature, they would be liable, as formerly explained, to be lost by accidental causes of destruction and by subsequent intercrossing; and so it is known to be under domestication, unless abrupt variations of this kind are specially preserved and separated by the care of man. Hence in order that a new species should suddenly appear in the manner supposed by Mr. Mivart, it is almost necessary to believe, in opposition to all analogy, that several wonderfully changed individuals appeared simultaneously within the same district. This difficulty, as in the case of unconscious selection by man, is avoided on the theory of gradual evolution, through the preservation of a large number of individuals, which varied more or less in any favourable direction, and of the destruction of a large number which varied in an opposite manner.

That many species have been evolved in an extremely gradual manner, there can hardly be a doubt. The species and even the genera of many large natural families are so closely allied together that it is difficult to distinguish not a few of them. On every continent, in proceeding from north to south, from lowland to upland, &c., we meet with a host of closely related or representative species; as we likewise do on certain distinct continents, which we have reason to believe were formerly connected. But in making these and the following remarks, I am compelled to allude to subjects hereafter to be discussed. Look at the many outlying islands round a continent, and see how many of their inhabitants can be raised only to the rank of doubtful species. So it is if we look to past times, and compare the species which have just passed away with those still living within the same areas; or if we compare the fossil species embedded in the sub-stages of the same geological formation. It is indeed manifest that multitudes of species are related in the closest manner to other species that still exist, or have lately existed; and it will hardly be maintained that such species have been developed in an abrupt or sudden manner. Nor should it be forgotten, when we look to the special parts of allied species, instead of to distinct species, that numerous and wonderfully fine gradations can be traced, connecting together widely different structures.

Many large groups of facts are intelligible

only on the principle that species have been evolved by very small steps for instance the fact that the species included in the larger genera are more closely related to each other and present a greater number of varieties than do the species in the smaller genera The former are also grouped in little clusters like varieties round species and they present other analogies with varieties as was shown in our second chapter On this same principle we can understand how it is that [illegible] ... or manner are more variable than other parts of the same species Many analogous facts all pointing in the same direction could be added

Although very many species have almost certainly been produced by steps not greater than those separating fine varieties yet it may be maintained that some have been developed in a different and abrupt manner Such an admission however ought not to be made without strong evidence being assigned The vague and in some respects false analogies as they have been shown to be by Mr Chauncey Wright which have been advanced in favour of this view such as the sudden crystallisation of inorganic substances or the falling of a facetted spheroid from one facet to another hardly deserve consideration One class of fact however namely the sudden appearance of new and distinct forms of life in our geological formations supports at first sight the belief in abrupt development But the value of this evidence depends entirely on the perfection of the geological record in relation to periods remote in the history of the world If the record is as fragmentary as many geologists strenuously assert there is nothing strange in new forms appearing as if suddenly developed

Unless we admit transformations as prodigious as those advocated by Mr Mivart such as the sudden development of the wings of birds or bats or the sudden conversion of a Hipparion into a horse hardly any light is thrown by the belief in abrupt modifications on the deficiency of connecting links in our geological formations But against the belief in such abrupt changes embryology enters a strong protest It is notorious that the wings of birds and bats and the legs of horses or other quadrupeds are undistinguishable at an early embryonic period and that they become differentiated by insensibly fine steps. Embryological resemblances of all kinds can be accounted for as we shall hereafter see, by the progenitors of our existing species having varied after early youth and having transmitted their newly acquired characters to their offspring at a corresponding age The embryo is thus left almost unaffected and serves as a record of the past condition of the species. Hence it is that existing species during the early stages of their development so often resemble ancient and [illegible] ... have undergone such momentous and abrupt transformations as those above indicated and yet [illegible] ... insensibly fine steps

He who believes that some ancient form was transformed suddenly through an internal force or tendency into [illegible] ... be denied that such abrupt and great changes of structure are widely different from those which most species apparently have undergone He will further be compelled to believe that many structures beautifully adapted to all the other parts of the same creature and to the surrounding conditions have been suddenly produced and of such complex and wonderful co-adaptations he will not be able to assign a shadow of an explanation He will be forced to admit that these great and sudden transformations have l[illegible] no trace of their action on the embryo To admit all this is, as it seems to me to enter into the realms of miracle and to leave those of Science

CHAPTER VIII

INSTINCT

MA Y instincts are so wonderful that their de- lopm t will probably ppear to the reader difficulty suffici t to rthrow my wh l theory I ma h re premise that I h n th w l th origi of th m ntal pow rs,

illustra ... an mals of th sam class.

I ll t tt mpt any definition f instinct. It would be asy to sh w that se al distinct mental actions are commonly mbraced by this t rm b t ry und rstands what is meant, hen t is said that instin t impels th cuckoo t m grat and to lay h ggs in the b rd ests. An action, which w ursel re- q ire experie ce to nabl us to perf rm hen performed b an animal, m re especiall b a ery oung w th t xperience and wh en performed by man in iduals in th sam w without th ir kno in f wh t p rpose it is performed is usuall said to be nstin tive B t I could sh w th t non f these haract rs are uni rsal. A l ttl d se f j dg ment reason, as Pierre Hube xpresses t, oft comes into play ev w th animals l w in th scal of nature.

Frederic C and se ral of th old m taphysicians ha compared instinct with hab t. This compariso gi es, I think, an ac curate notio of th fram f mind und which an in tinct actio is perf rmed b t not necessarily of ts origin. H w unconscious- l man hab tual actions are perf rmed, in deed not rarel in direct pposition to ur conscious will Y t th ma be modified by tl ill reaso Hab t easily becom asso- ciated w th th hab ts, w th certain periods of tim and tates of the body Wh n nce acquired, th often remai constant thro gh out life. Se ral th points of resemblance betwe instincts and hab ts co ld be pointed out As in repe ting ll know song, so in instincts, on actio f llow anoth by sort of h thm if perso be int rrupted in song, repe t an thin b rote h is generall f rced t g back to reco th habitual tra of tho ht so I H be f und it was th cat p llar wl ich makes ery compl icated hammock for if he took ater pillar which had completed ts hammock up to sa the sixth tag of constru tion, and p t t into a hammock compl ted up onl t th third tage th cat rpillar simply re perfo med th fourth, fifth, and sixth tages of constru ti n. If howe r a cat rpillar were ... wo k was already don f r t, far from d ri ing any be fit from this, t was much mbar rassed, and in o de to compl t ts h mmock, seemed f rced t tart from th third tage wh re t had l ft off and thus tried to com pl te th already finished w k.

If w ppose an hab t al c n t b com inh rited—and t can be sh wn that th does som *times h ppen—th n th resemblance* between what riginally was a hab t an l an instinct becomes so close as n t to be d t guished If Mozart instead of playing th pian f rte t three y ars ld with wond f lly littl practice had pla ed a tun with practice t all, h might truly be said to h d e so in tinct ly But t w uld be a serio rro t ppose that th great r number of instincts ha been cquired by hab t in o e g ration, and th n transm tted by inh ri *tance to cceedin g rat ns. It can b* clearl h wn that th most wonderful tincts with which w are acquainted nam l those f th hi -bee and f many ants, could not possibly ha been acquired b hab t.

It will b un rsally adm tted that in tin ts are as important as corporeal truc tures f th w lfare f ach species, und ts prese t conditions f lif I d changed co d tions f lif t is t least possibl that slight modifications f instin t m ght be profitabl to spec es and if t can be shown th t in tin ts d ary ev so littl th n I can see no difficulty in natural sel ct prese ving and co tinually accum lating ariations of in *tinct to any t* t that was profitabl It is thus, as I believ that all th most compl x and w d rful instincts ha originated As modifications of corporeal tru ture arise from, and are increased by se o hab t, and are diminished lost by disuse so I d not d ubt t has been w th instincts. B t I bel that

the effects of habit are in many cases of subordinate importance to the effects of the natural selection of what may be called spontaneous variations of instincts —that is of variations produced by the same unknown causes which produce slight deviations of bodily structure

No complex instinct can possibly be produced through natural selection except by the slow and gradual accumulation of numerous slight yet profitable variations Hence as in the case of corporeal structures we ought to find in nature not the actual transitional gradations by which each complex instinct has been acquired—for these could be found only in the lineal ancestors of each species—but we ought to find in the collateral lines of descent some evidence of such gradations or we ought at least to be able to show that gradations of some kind are possible and this we certainly can do I have been surprised to find making allowance for the instincts of animals having been but little observed except in Europe [illegible] N [illegible]

[illegible] is can be discovered Changes of instinct may sometimes be facilitated by the same species having different instincts at different periods of life or at different seasons of the year or when placed under different circumstances &c in which case either the one or the other instinct might be preserved by natural selection And such instances of diversity of instinct in the same species can be shown to occur in nature

Again as in the case of corporeal structure and conformably to my theory the instinct of each species is good for itself but has never as far as we can judge been produced for the exclusive good of other One of the strongest instances of an animal apparently performing an action for the sole good of another with which I am acquainted is that of aphides voluntarily yielding as was first observed by Huber their sweet excretion to ants that they do so voluntarily the following facts show I removed all the ants from a group of about a dozen aphides on a dock plant, and prevented their attendance during several hours After this interval I felt sure that the aphides would want to excrete I watched them for some time through a lens but not one excreted I then tickled and stroked them with a hair in the same manner as well as I could as the ants do with their antennæ but not one excreted Afterwards I allowed an ant to visit them and it immediately seemed by its eager way of running about to be well aware what a rich flock it had discovered it then began to play with its antennæ on the abdomen first of one aphis and then of another and each as soon as it felt the antennæ immediately lifted up its abdomen and excreted a limpid drop of sweet juice which was eagerly devoured by the ant. Even the quite young aphides behaved in this manner showing that the action was instinctive and not the result of experience It is certain from the observations of Huber that the aphides show no dislike to the ants if the latter be not present they are at last compelled to eject their excretion But as the excretion is extremely viscid it is no doubt a convenience to the aphides to have it remo [illegible]

[illegible] mal performs an action for the exclusive good of another species yet each tries to take advantage of the instincts of others, as each takes advantage of the weaker bodily structure of other species So again instincts cannot be considered as absolutely perfect but as details on this and other such points are not indispensable they may be here passed over

As some degree of variation in instincts under a state of nature and the inheritance of such variation are indispensable for the action of natural selection as many instances as possible ought to be given but want of space prevents me I can only assert that instincts certainly do vary —for instance the migratory instinct both in extent and direction and in its total loss So it is with the nests of birds, which vary partly in dependence on the situations chosen and on the nature and temperature of the country inhabited but often from causes wholly unknown to us Audubon has given several remarkable cases of differences in the nests of the same species in the northern and southern United States Why it has been asked if instinct be variable has it not granted to the bee the ability to use some other material when wax was deficient ? But what other natural material could bees use? They will work as I have seen with wax hardened with vermilion or softened with lard Andrew Knight observed that his bees instead of laboriously collecting propolis used a cement of wax and turpentine with which he had covered decorticated trees It has lately been

shown that bees, instead of earching f r pollen, will gladly use a very d ffere t ub- stance amely oatmeal. Fear of any parti ular nemy i certainly an instin ti e qualit as may be see in n thing birds, th ugh t is tr gthe ed by experie ce, and b the sight of f ar of the same en my in oth r imals. The fear of man is slowly acq red a I have lsewh re sh wn by th arious an im ls h ch nhab t d sert islands and w see an in tance of th s n E gland in the gre te w ld ss of all r larg bird in comparison with ur mall b rd f th larg birds h v been most persecuted by man. W m y safely ttribute th gre t w ld ess f our larg b rd t thus ca se f r in nınl ab ted slands large b rd are t m re fearful than small and th mag pie so wary in E gland, tam in N rway as is th hooded crow in Egypt.

That th mental q al ti s f animals f th sam ki d born in a stat f n t re ary much co ld be h wn by many facts. Se l case co ld also b add ced f occas al an l trang h l t wild animals, wh ch if ad vant geo to the pecies, might l a e gi rise, thro gh tural selecti n, to new tin ts. B t I am well ware th t these gei ral tat m nts, th t the facts in d tail, will prod ce b t a feeble ffect tl e read mind. I can nly repeat m ass ance, that I do not speak w th t good ide ce.

Inherited Ch nges of Habit or Instinct in Domesticated An mals

Th possib lity o n probability of in h rited ariati s f nstinct in tat f nat re will be strength ed by bri fly con sid ring a f w case und d mest cation. W shall thus be nabled t see the part wh ch hab t and tl select o of so-called pon taneo ari t ns ha played in mod fying th m tal q al t f d mest an mals. It is notorio h w m ch d mestic an mals ary in their m tal qual t es. W th cats, f instance nat ally tak to catch g ts, and an th mice and these tend ncies are known t be nh rited O e cat, accord g t M t J hn, alw y bro ght h m game- b rds, an th hares rabb ts, and anoth h ted marshy gro d and almost ghtly ca g t oodcocks sn pes. A mbe of curio and th tic nstances co ld be gi n of ar us shades of d posit and f taste and like se of th oddest tricks, associated th certain frames f m nd or period f time, bei g nherited B t l t look to the familiar case of the breeds of the dogs it cannot be doubted that y ung pointers (I have myself seen a triking in tance) will sometimes point and en back other dogs the very first time th t they are taken o t retrieving is certainly in some d gree inherited by retri vers and a tenden y to run round inst ad of at, a flock f sheep, by sheph rd dogs. I cannot see that these actio s, perf rmed without experience by the y ung and in ne ly the same manner by ach ind d al, performed with eag r de- l ght by each breed and w thout the e d b ng kn wn—f th y ng pointer can n more

wh n you g and w th t any training as soon as t scented t prey stand motionl ss like a statue, and then slowly crawl forward w th a pecul ar gait and anoth kind f w lf rushing rou d instead f t, a h rd of deer and dr v i g th m t distant point, w should as- s redly call these acti ns instinct e. D mes- t c instincts, as they m y be called are cer t ly far less fi ed than n t ral in tincts b t th y ha e been acted on by far l ss rigorous selecti n, and ha e been tran m tted f r an ncomparably ho ter period under less fixed co d ti ns f life

H w tro gly these d mesti instin ts, hab ts, and dispos t ns are inh rited nd h w curi sly th y become mingled is w ll l wn wl n diff rent breeds f d gs ar crossed Thus t is kn wn th t a cross w th a bull-d g l as ffected f r many g rat s the cou and b ti acy f grey l nd and a cross w th a greyhound has gi en to a wh le family f h ph rd-dogs a tendency to hunt h res. These d mesti in tincts, wh n thus tested by cross- g resemble natural instin ts, which in a like manner become curi u ly blended t g th and f a long period exhib t traces f the in sti cts f th pare t for exampl Le R y describes a d g, wh se great grandfath was a w lf and thi d g sh wed trace f its w ld parentag nly in w y by n t coming in tra g t l e to his maste wh n called

D me t instincts re sometimes p k of as act ns which h e becom nh rited solely from long-co tin ed and compulsory h b t b t this is t true No would r h e th ght f t ach ng, probably could h e ta ght, th tumbl p geon to tumbl —an ac tion which, as I hav witnessed, is perf rmed

the effects of habit are in many cases of subordinate importance to the effects of the natural selection of what may be called spontaneous variations of instincts —that is of variations produced by the same unknown causes which produce slight deviations of bodily structure

No complex instinct can possibly be produced through natural selection except by the slow and gradual accumulation of numerous slight yet profitable variations Hence as in the case of corporeal structures we ought to find in nature not the actual transitional gradations by which each complex instinct has been acquired—for these could be found only in the lineal ancestors of each species—but we ought to find in the collateral lines of descent some evidence of such gradations or we ought at least to be able to show that gradations of some kind are possible and this we certainly can do I have been surprised to find making allowance for the instincts of animals having been but little observed except in Europe and North America and for no instinct being known amongst extinct species how very generally gradations leading to the most complex instincts can be discovered Changes of instinct may sometimes be facilitated by the same species having different instincts at different periods of life or at different seasons of the year or when placed under different circumstances &c in which case either the one or the other instinct might be preserved by natural selection And such instances of diversity of instinct in the same species can be shown to occur in nature

Again as in the case of corporeal structure and conformably to my theory the instinct of each species is good for itself but has never as far as we can judge been produced for the exclusive good of others One of the strongest instances of an animal apparently performing an action for the sole good of another with which I am acquainted is that of aphides voluntarily yielding as was first observed by Huber their sweet excretion to ants that they do so voluntarily the following facts show I removed all the ants from a group of about a dozen aphides on a dock plant, and prevented their attendance during several hours After this interval I felt sure that the aphides would want to excrete I watched them for some time through a lens but not one excreted I then tickled and stroked them with a hair in the same manner as well as I could as the ants do with their antennæ but not one excreted Afterwards I allowed an ant to visit them and it immediately seemed by its eager way of running about to be well aware what a rich flock it had discovered it then began to play with its antennæ on the abdomen first of one aphis and then of another and each as soon as it felt the antennæ immediately lifted up its abdomen and excreted a limpid drop of sweet juice which was eagerly devoured by the ant. Even the quite young aphides behaved in this manner showing that the action was instinctive and not the result of experience It is certain from the observations of Huber that the aphides show no dislike to the ants if the latter be not present they are at last compelled to eject their excretion But as the excretion is extremely viscid it is no doubt a convenience to the aphides to have it removed therefore probably they do not excrete solely for the good of the ants Although there is no evidence that any animal performs an action for the exclusive good of another species yet each tries to take advantage of the instincts of others, as each takes advantage of the weaker bodily structure of other species. So again instincts cannot be considered as absolutely perfect but as details on this and other such points are not indispensable they may be here passed over

As some degree of variation in instincts under a state of nature and the inheritance of such variation are indispensable for the action of natural selection as many instances as possible ought to be given but want of space prevents me I can only assert that instincts certainly do vary—for instance the migratory instinct both in extent and direction and in its total loss So it is with the nests of birds, which vary partly in dependence on the situations chosen and on the nature and temperature of the country inhabited but often from causes wholly unknown to us Audubon has given several remarkable cases of differences in the nests of the same species in the northern and southern United States Why it has been asked if instinct be variable has it not granted to the bee the ability to use some other material when wax was deficient ? But what other natural material could bees use? They will work as I have seen with wax hardened with vermilion or softened with lard Andrew Knight observed that his bees instead of laboriously collecting propolis, used a cement of wax and turpentine with which he had covered decorticated trees. It has lately been

first laid w uld ha to be left fo some tim unincubated th re w ld be ggs and oung birds of diff rent ag s in th same est. If this w re the case the process f la ing and hatching m ght be incon eni tly l g more especially as sh m grate at a v ry arly period and th first h tched y g w uld probably ha to be fed by th male alone. B t th Am rican cuckoo is in this predica- ment f sh makes h wn nest, and has eggs and ung succes. I h tched all t th sam time. It has bee both asserted and denied that the Am rican cu koo occasi nally la her ggs tl b rd ests b t I h ve lat l heard from D M rrell f I wa, that h once found in Illin is ckoo to- gether with a ung y s in th n t of Il y (Garrul crstat) and a both w re earl f ll f th red th re co ld be mis- tak in th ir id ntification. I co ld lso g se ral instances of arıou bird wh h ha been known occasionall t l y th ir ggs in othe bird nests. N w l t us ppose th t the anci t pro nito of ur European cuckoo had th hab ts of th Am rican ckoo and that sh occasionall laid an gg in another bird nest. If th old bird profited by this occasi nal hab t thro gh being nabled to migrate earh throu l any th cause or if th youn w re mad m re goro by ad anta being tak of th mistaken instinct of anoth species than when reared by their wn m th encumbered as he could hardly fail to be b ha ing gg and y ung f diff re t age t th sam tim th n th ld bird or

inl ritance th occa io al and aberrant hab t of their moth and their turn w uld be apt to la their eggs in th birds ests, and thus be more successf l in rear g th g. By a contin ed process of th nature I beh that th trang instinct of o cuckoo has been gen rated It has, also, rece tl been ascer tained on suffi t idence b Ad ll M ll that the cuckoo occa ionally la h ggs the bare gro nd its th m, and feed her young. This rare ent is probabl case of re rsio t the long lost, aboriginal in tinct of id fication.

It has been objected that I ha t noticed othe related instincts and ad ptations of structure th cuckoo, which are poken of as ecessarily co-ordinated. B t in all cases, speculation on an instinct known to us only in a single species, s useless, fo we ha e h th erto had facts to guid us. Until recentl th instin ts of the European and of tl n n- parasiti Am rican cuckoo al n were known n w wing to Mr Ramsay s observ ati ns, we h learnt som th g about three Australian species, wh ch lay the ggs n oth b rd n ts. Th clu f points to be ref rred to are three first, th t the comm n cuckoo, with rare xcept ns, la s only e gg in nest, so th t th larg and rac ous young b rd re- ce es ampl food Secondly that th ggs are remarkably small not ceeding those f th skylark,—a b rd bout one fourth as large as th cuckoo Th t th mall size f the egg is a real cause f adaptati n w may infe from the fact of th on paras tic American cuckoo lay ing f ll-sized ggs. Thirdl th t the ng cuckoo soo ft r b rth, has th in tinct the tre gth and a prope ly sh ped back f ject ing ts fo t broth rs, hich tl n perish from cold and hunger This has been boldly called a ben fice t arrangement, in rde that th

Turning n w t tl Au tralian species th gh these bird g ne ally lay nly o gg in nest, t is n t rare to find two o v n three gg in the same nest. In the bro ze cuckoo th g s ary gre tly in size from ght to t n times n length. N w if t had been of an ad antag t thi pecies to have laid gg e n mall than those n w laid so as t h dece ed certain fost pare ts, or as m re probabl to h been h tched within sh rt period (f t asserted that there is a relatio between th ize of ggs and th period of th ir incubat n) then th re is n difficulty n bel ng th t a ace pec.es might ha e bee f rmed which w uld hav laid mall and mall g s for these w uld ha bee m re saf l hatched and reared Mr Ramsa remarks that tw of the Aus- tralian cuckoos, wh n they lay their eggs in an pen nest, manifest a decided pref rence f nests co taining gg m lar in colour t their wn. Th E ropean speci pparentl manifests som t d cy toward m lar instinct, b t t rarely d parts from t, as is sh wn b h laying h dull and pale-col red eggs in the nest of th Hedge-warble w th bright greenish bl ggs. Had ur uckoo invariabl displayed th abo instinct, t would assuredly ha e been added t those which t is assumed must all hav been ac-

by young birds that have never seen a pigeon tumble We may believe that some one pigeon showed a slight tendency to this strange habit, and that the long-continued selection of the best individuals in successive generations made tumblers what they now are and near Glasgow there are house tumblers as I hear from Mr Brent which cannot fly eighteen inches high without going head over heels It may be doubted whether any one would have thought of training a dog to point had not some one dog naturally shown a tendency in this line and this is known occasionally to happen as I once saw in a pure terrier the act of pointing is probably as many have thought only the exaggerated pause of an animal preparing to spring on its prey When the first tendency to point was once displayed methodical selection and the inherited effects of compulsory training in each successive generation would soon complete the work and unconscious selection is still in progress as each man tries to procure without intending to improve the breed dogs which stand and hunt best On the other hand habit alone in some cases has sufficed hardly any animal is more difficult to tame than the young of the wild rabbit scarcely any animal is tamer than the young of the tame rabbit but I can hardly suppose that domestic rabbits have often been selected for tameness alone so that we must attribute at least the greater part of the inherited change from extreme wildness to extreme tameness to habit and long continued close confinement

Natural instincts are lost under domestication a remarkable instance of this is seen in those breeds of fowls which very rarely or never become broody that is never wish to sit on their eggs Familiarity alone prevents our seeing how largely and how permanently the minds of our domestic animals have been modified It is scarcely possible to doubt that the love of man has become instinctive in the dog All wolves foxes jackals and pecies of the cat genus when kept tame are most eager to attack poultry sheep and pigs and this tendency has been found incurable in dogs which have been brought l ome as puppies from countries such as Tierra del Fuego an l Australia where the savages lo not keep these domestic animals How rarely on the otl er hand do our civilised dogs even v hen quite young require to be taught not to attack poultry sheep and pigs! No loubt they occasionally do make an attack and are then

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l ... On the other hand young chickens have lost wholly by habit that fear of the dog and cat which no doubt was originally instinctive with them for I am informed by Captain Hutton that the young chickens of the parent-stock the Gallus bankiva, when reared in India under a hen are at first excessively wild So it is with young pheasants reared in England under a hen It is not that chickens have lost all fear but fear only of dogs and cats for if the hen gives the danger-chuckle they will run (more especially young turkeys) from under her and conceal themselves in the surrounding grass or thickets and this is evidently done for the instinctive purpo e of allowing as we see in wild ground birds their mother to fly away But this instinct retained by our chickens has become u eless under domestication for the mother hen has almost lost by disuse the power of flight

Hence we may conclude that under domestication instincts have been acquired and natural instincts have been lost p rtly by habit and partly by man selecting and accumulating during successive generation. peculiar mental habits and actions wl ich at first appeared from what we must in our ignorance call an accident. In some cases compulsory habit alone has sufficed to produce inherited mental changes in other cases compulsory habit has done nothing and all has been the result of selection pursued both methodically and unconsciously but in most cases habit and selection have probably concurred

Special Instincts

We shall perhaps best un lerstand how instincts in a state of nature have become modified by selection l v con ... cases

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... of the Cucl oo —It is suppos l by some naturalists that the more immediate cause of the instinct of the cuckoo i that she lays l er eggs not daily but at intervals of two or three lays so that if he were to make her own nest an l sit on l er own eggs those

ably be accounted f by the fact f the h ns laying large umber of ggs, b t, as w th the cuckoo, t intervals of t three days. The instinct, how f th Am rican ostrich, as in th case of th M l thrus bonariensis, has not as y t been perfected for surprising number of ggs h trewed ove th plains, so that in d y s hunti I p cked up no less than tw nty lost and wasted eggs.

Many bees are parasitic, and regularly lay their eggs in th nests of othe kinds of bees. This case is m re remarkabl than th t f the cuckoo f these bee ha n t nly had th r instincts b t th ir tructure modified in ac cordance with th ir parasitic hab ts fo th y d t possess th poll n-collecting pparatus which w uld h been ind pensabl if th y had t red p food f th ir wn y ung. Som specie of ph gidæ (wasp-like insects) are likewise parasitic and M. Fabre has lately shown good reaso f bel ng th t, although the *Tachyte gra* gen rally makes ts wn burrow and t res t with paralysed prey fo ts wn larvæ, y t that, wh n this insect finds burrow already mad and t red by anoth sphex, t tak ad antag of the priz and be comes f the occasi n parasitic. In this case as with that of th M lothrus cuckoo, I can see no difficulty in natural selection making an occasional hab t permanent, if f advantag to th species, and if th insect whose est and t red food are f loniously appropriated be not thus t rminated

Slav making nst ct.—This remarkabl in tinct was first disco red in the *F rm ca (Polyerges) ruf scens* by P rre H be bett observ en than his celebrated f th r This ant is absol tel dependent its sla es without th ir aid th species would certainly becom t ct in ngle year The males and f rtil f male d no w k of any kind and th orkers or terile f males, th ugh most en g ti and courageous in apturing sla es, do no th w k. They are incapable f making their w nests, or of feedin their wn larvæ. Whe th ld est is found incon nient, and the ha to migrate t is th sla es which d termine th migration, and actually carry their mast rs th eir j ws. So tt ly h lpless are the mast rs, that when Hube sh t p thirt of th m w thout la b t with plenty of the food hich th lik best, and with their n larvæ and pupæ to tim lat th m to ork, th did nothing they could not en feed themsel s, and man perished of hung Huber then introduced ingle slave (*F fusca*) and she instantl set to wo k fed and sa ed the surv rs mad som cells and tended the larvæ and put all to rights. What can be more xt aordinary than these well-ascertained facts If w had not kn wn of any th r sla e-making ant, it wo ld h e been hopeless to peculate h w so wonderful an t could ha been perfected

south rn parts

r Sm h f th

H be and M Sm th, I tried to pproach the subject in a sceptical frame of mind as any one may well be excused f doubting th istence of so extraordinary an instinct s that f making slaves. Hence, I will giv th observations which I mad in som littl d tail. I opened fourteen nests of *F sa gu nea*, and f und a few sla in all. Males and f rt le females f th sl species (*F fusca*) are f und only in their wn proper communities, and ha ne been observed in th nests of *F sa guinea*. Th sla es are black and not abo e half th size f th ir red masters, so that the

nest is m ch disturbed, and the larvæ and p pæ are exposed th sla es wo k en rg ti cally togeth with their masters in carrying th m w y to place f saf ty Hence, t is cl ar that th sla es feel quit t h me. D ing th m nths f J n and July n three uccessi e years, I w tched f many h urs se ral ests in Surrey and Sussex, and ne r saw a lave th l at a ne t. As, during th se m nths, the sla es are very few in number I tho g t that th y might beha e differentl wl n m re num rous but Mr Sm th informs m that h has w tched th nests t arious hours durin May Ju nd A gust, both in Surre and Hampshire and has n seen th slaves, th ugh present in large numbers in A gust, ther lea ente th nest. Hence h considers th m as trictly h usehold slaves. The mast rs, on th ther hand may be constantly seen bringing in materials f th nest, and food f all kind During th year 1860 h we in the m th of July I cam across a community with an

quired together The eggs of the Australian bronze cuckoo vary according to Mr Ramsay to an extraordinary degree in colour so that in this respect as well as in size natural selection might have secured and fixed any advantageous variation

In the case of the European cuckoo the offspring of the foster parents are commonly ejected from the nest within three days after the cuckoo is hatched and as the latter at this age is in a most helpless condition Mr Gould was formerly inclined to believe that the act of ejection was performed by the foster parents themselves But he has now received a trustworthy account of a young cuckoo which was actually seen whilst still blind and not able even to hold up its own head in the act of ejecting its foster brothers One of these was replaced in the nest by the ol — l was

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... it were of great importance for the young cuckoo as is probably the case to receive as much food as possible soon after birth I can see no special diffic lt

... or the work of ejection for those young cuckoos which had such habits and structure best developed would be the most securely reared The first step towards the acquisition of the proper instinct might have been more unintentional restlessness on the part of the young bird when somewhat advanced in age and strength the habit having been afterwards improved and transmitted to an earlier age I can see no more difficulty in this than in the unhatched young of other birds acquiring the instinct to break through their own shells —or than in young snakes acquiring in their upper jaws as Owen has remarked a transitory sharp tooth for cutting through the tough egg shell For if each part is liable to individual variations at all ages, and the variations tend to be inherited at a corresponding or earlier age —propositions which cannot be disputed —then the instincts and structure of the young could be slowly modified as surely as those of the adult and both cases must stand or fall together with the whole theory of natural selection

Some species of Molothrus, a widely distinct genus of American birds allied to our starlings, have parasitic habits like those of the cuckoo and the species present an interesting gradation in the perfection of their instincts. The sexes of *Molothrus badius* are stated by an excellent observer Mr Hudson sometimes to live promiscuously together in flocks, and sometimes to pair They either build a nest of their own or seize on one belonging to some other bird occasionally th ... e nest

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... y sit on their own eggs and rear their own young but Mr Hudson says it is probable that they are occasionally parasitic for he has seen the young of this species following old birds of a distinct kind and clamouring to be fed by them T ...

... t are still far from perfect. This bird as far as it is known invariably lays its eggs in the nests of strangers but it is remarkable that several together sometime commence to build an irregular untidy nest of their own placed in singularly ill adapted situations as on the leaves of a large thistle They never however as far as Mr Hudson has ascertained complete a nest for themselves They often lay so many eggs—from fifteen to twenty—in the same foster nest, that few or none can possibly be hatched They have moreover the extraordinary habit of pecking holes in the eggs whether of their own species or of their foster parents which they find in the appropriated nests They drop also many eggs on the bare ground which are thus wasted A third species the *M pecoris* of North America has acquired instincts as perfect as those of the cuckoo for it never lays more than one egg in a foster nest so that the young bird is securely reared Mr Hudson is a strong disbeliever in evolution but he appears to have been so much struck by the imperfect instincts of the *Molothrus bonariensis* that he quotes my words and asks, "Must we consider these habits not as especially endowed or created instincts but as small consequences of one general law namely transition?"

Various birds, as has alre ...

... us unite and lay first a few eggs in one nest and then in another and these are hatched by the males. This instinct may prob-

th r l e and larvæ. So that the masters in this co try rece e much l ss se ce from thei l es tl an tl y d in S tze land

By wh t step th nstin t f F a g n a riginated I w ll n t prete d to co ject re B t as ants wh ch re n t l e-make s will as I b e seen, carry ff tl p pæ f th r tt red n th ne t t pos-

co ld If th prese ce pro ea se pec wh h had se ed th m—if t w re m re ad antageous to th pec to captur w k rs tl an to procr t th m—tl h b t f col lect g p pæ riginally fo food m ght by t al select o b t ngtl ed and e d red permane t fo the ry d ffer nt p rpo f re

sam pec

tio m ght crease and modify tl nsti t— al s pposing ach mod ficatio t b f use to tl pec — t l an ant was f med as abjectly d p d t n t la s as the *F rmica ruf cens*

C ll-mak g inst ct f the H B —I w ll t h re t min t d tail n thi b-

h ar from m tl m tician th t b ha p ac ti ll sol ed reco d te p bl m d l mad tl cells f tl prope l pe t h ld the gre t t poss bl m t f h w tl the l ast po bl co mpt f prec wax th co truct It has bee rema ked tl t k ll l w kman w th fitt g tool nd m as- res, ld fi d t rv d ffi lt t mak cell f ax f th tru f rm tl gh th ffected by n d f bee w k g a d k l Grant g wl t u ts pl ase t see is t first q t cc r abl l w th y can mak all tl ecessary gles and pl s, perce h tl ar co rectly mad B t tl d fficulty t arl so gre t as t t first ppears all th be tif l w k can be sho n, I tl k, t f llow from few mpl in t cts.

I was led to est g t tl bject by M W t l se who has sl w that tl f rm f the cell stand n l e relat on to the presence f adj ning cell and th foll ing v ew m y pe hap b co dered ly as a mod fication f thi theo y Let us look t the gr at prin cipl f g ad t nd s e wl ther N tu e h r m thod of work At

ul r rou ded cell f wax At the ne e u tl se w l a e the cells f the hi e bee placed in a d ble l ye each c ll as i well kn wn, an h xag al prism, w th th bas l edge f ts ix d be elled o as to join an d n r m d f three rhombs Tl se

po t f th base f th ee adj in g cells n th

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P re Hube The M l pona itself is inter

f yl d cal cells, n wh ch the young h t hed d n add t on som large lls f w x f r l ld g h n Th e latt c lls are ly ph rical d f n ly eq al iz a d r ggreg ted int an rregula mass B t th mpo tant point to n t ce s, that th se ells lway mad t th t d g ee f n m ss to ach tl tl t th y w ld h v inte sect d brok n t each th if the sph l ad been mpl ted b t th s is ne pe m tted tl b es bu lding p f tly flat walls f wax b twee th ph re wh h thu tend t nt ect H ce, ach cell con ts of n out ph n l port n and f tw three r m re fl t rfaces, accord g as th c ll adj ins t th ee m th r cell When n cell re ts th ee tl cells, wh ch from th ph s b g n ly f tl sam e, is c y f qu t ly and ecessarily tl case th thre fl t faces ar nited nt a pyr m d nd tl s py m d as H b l as rem ked s manif tly gross m tat f tl thr sided py m dal base f th cell f tl e h e-bee A in th ll f tl l l ce so l tl three p ane r face any cell ce sar ly t to th constru t f tl ree adj g cells. It is ob

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. . Scotch fir tree twenty five yards distant which they ascended together probably in search of aphides or cocci According to Huber who had ample opportunities for observation the slaves in Switzerland habitually work with their masters in making the nest and they alone open and close the doors in the morning and evening and as Huber expressly states their principal office is to search for aphides This difference in the usual habits of the masters and slaves in the two countries probably depends merely on the slaves being captured in greater numbers in Switzerland than in England

One day I fortunately witnessed a migration of *F sanguinea* from one nest to another and
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aves in
em as
in the case of *F rufescens* Another day my attention was struck by about a score of the slave makers haunting the same spot and evidently not in search of food they approached and were vigorously repulsed by an independent community of the slave species (*F fusca*) sometimes as many as three of these ants clinging to the legs of the slave making *F sanguinea* The latter ruthlessly killed their small opponents and carried their dead bodies as food to their nest twenty nine yards distant but they were prevented from getting any pupæ to rear as slaves I then dug up a small parcel of the pupæ of *F fusca* from another nest and put them down on a bare spot near the place of combat they were eagerly seized and carried off by the tyrants who perhaps fancied that after all they had been victorious in their late combat

At the same time I laid on the same place a small parcel of the pupæ of another species *F flava* with a few of these little yellow ants still clinging to the fragments of their nest This species is sometimes though rarely made into slaves as has been described by Mr Smith Although so small a species it is very courageous and I have seen it ferociously attack other ants In one instance I found to my surprise an independent community of *F flava* under a stone beneath a nest of the slave making *F sanguinea* and when I had accidentally disturbed both nests the little ant attacked their big neighbours with surprising courage Now I was curious to ascertain whether *F sanguinea* could distinguish the pupæ of *F fusca* which they habitually make into slaves from those of the little and furious *F flava* which they rarely capture and it was evident that they did at once distinguish them for we have seen that they eagerly and instantly seized the pupæ of *F fusca* whereas they were much terrified when they came across the pupæ or even the earth from the nest of *F flava* and quickly ran away but in about a quarter of an hour shortly after all the little yellow ants had crawled away they took heart and carried off the pupæ

One evening I visited another community of *F sanguinea* and found . . .

. . . as not a migration) and numerous pupæ I traced a long file of ants burthened with booty for about forty yards back to a very thick clump of heath whence I saw the last individual of *F sanguinea* emerge carrying a pupa but I was not able to find the desolated nest in the thick heath The nest however must have been close at hand for two or three individuals of *F fusca* were rushing
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Such are the facts though they did not need confirmation by me in regard to the wonderful instinct of making slaves Let it be observed what a contrast the instinctive habits of *F sanguinea* present with those of the continental *F rufescens* The latter does not build its own nest does not determine its own migrations does not collect food for itself or its young and cannot even feed itself it is absolutely dependent on its numerous slaves *Formica sanguinea* on the other hand possesses much fewer slaves and in the early part of the summer extremely few the masters determine when and where a new nest shall be formed and when they migrate the masters carry the slaves Both in Switzerland and England the slaves seem to have the exclusive care of the larvæ and the masters alone go on slave making expeditions In Switzerland the slaves and masters work together making and bringing materials for the nest both but chiefly the slaves tend and milk as it may be called their aphides and thus both collect food for the community In England the masters alone usually leave the nest to collect building materials and food for themselves,

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rıdg of ax I som p rts, nly small po tıons, ın th parts, larg port ns f a bomb c pl t were th s left bet een the p- posed bas s, but th wo k, from tl un t al tate f th gs had n t bee atly

I thus s cceed d l g fl t plat be- t ee th l as s, by t pp ng w k t the pla es f t rsect

C n id rıng h w fl bl tl ın wax ıs, I do

topp g th ır w k. In rdinary coml t has ppeared t m th t the bees d ot lw y cceed ın w kıng t xactly tl e sam r t from tl pposıt sıdes f I l otıced l alf-completed h ml t tl base f a j t commenced cell, l l re l gl tly co e e s d here I ppose that the bees had ca ted too q ckly and co n tl e p- posed sıd wh re tl bee l ad w ked l ss q kly In ll ma ked ısta c I p t th comb back t tl h aı d allowed the bees to g k g f b rt t and agaı xam ed tl ell d I f und that the bomb plat l ad bee compl ted and had becom pe f tly flat ıt was absol t ly ım pos bl f m tl tr m tl ınn ss f the lıttle plat that tl y co ld l ffected tl by gna g y tl co d an I I pect tl t tl bees ın h cases tand pposıte les and p sl nd bend th d tıl and warm wax (hıcl as I h trıed ıs asıly d) ınto ts prope ınt rmedıate plan and th flatten t.

From tl pern nt f th rıdg f er mılıo ax an see tl t, f th bees w re t l ld f th sel thın all f w tl co ld mak tl cell f tl proper al pe by taı dıng t th prope d ta ce from ac th b xca t g t tl sam rate, and l nd rı g t mak eq al ph rıcal hollo s, l t n allowıng tl pheres to break ınt ach tl w bees, as may be clearl see by xamınıng th edge f grow ıng comb d mak rougl cırcumf re tıal wall rım all ro nd tl comb and th y gnaw thıs w y from th pposıt sıdes, alw ys wo kıng cırcularly as they deepen each cell Th y d n t mak the wh le three ıded pyra m dal base of any on cell t the same tıme but only tl t ne rh mb c plate whıch stands n th e treme gro ıng m rgın, or the two plat s, as the case m y be and they n ve complete the uppe edges of the rh mb c pl tes, untıl the he g nal w lls are com me ced Som of tl se tatem nts dıffer from those made by th justly cel b ted elder Hub r but I am con ced f the r accuracy and ıf I l ad space I wo ld show th t th y are conf mabl wıth my theory

H b statem nt that th ery fırst cell ıs e cavated out f a l ttl parallel ded wall f wax ı not, as far as I h ve seen, trı tly correct tl fırst comm cement ha ıng al w ys bee l ttl l ood of wax but I wıll n t h re te o d ta ls We see how mpo tant part ca t on pl y ın th con truct on f the cells b t t w ld b gr t erro to sup- pose that tl bees cannot buıld up a ro gh wall f wax n the prope po t n—th t ıs al g tl plane f ıntersectı n b tween tw adj ın g pheres. I l a eve al pecım n sh wıng cl arly that they can d thıs. Even ın th rude cırc mf re tıal rım wall of wax ro d a grow g comb fle u es may som t mes be bserved co re pond g n po t on to the pla es f th h mb c basal plate of fut re cells. But tl ro gh wall of wax has ın ry case to b fi l ed ff by b ıng larg ly gnawed a y both l s. The manne ın whı h tl b b ld urıo s they al ays mak tl fırst ro gh w ll from ten t twenty t mes th k tl n the excess ely thın fın ı hed ll f tl cell wh ch w ll ult mately be l ft W hall l tand l w tl y w k by

the masons alw y p lıng ı p the cut w y cem t, and add g fre l cement n the sum mıt f tl rıdg W shall tl us h a thın wall tead ly gr w g upward but l ays crowned by a g gantıc copın From ll the cells, b tl those j t comm ed and those compl ted b ıng tl u crowned by a tro g cop g f wax th bee can lust and wl tl comb wıtl t ınjurı g the d l cate h g nal walls. Th se walls, as Professo M ll has kı dly ascertaıned fo me, ary gre tly tl kness be g an av g of tw l meas rem t mad near th bord f th comb y g f an ınch n thıckn ss wh reas

is more important labour by this manner of building for the flat walls between the adjoining cells are not double but are of the same thickness as the outer spherical portions and yet each flat portion forms a part of two cells

Reflecting on this case it occurred to me that if the Melipona had made its spheres at some given distance from each other and had made them of equal sizes and had arranged them symmetrically in a double layer the resulting structure would have been as perfect as the comb of the hive bee Accordingly I wrote to Professor Miller of Cambridge and this geometer has kindly read over the following statement drawn up from his information and tells me that it is strictly correct —

If a number of equal [illegible] or radius × 1 41421 (or at some lesser distance) from the centres of the six surrounding spheres in the same layer and at the same distance from the centres of the adjoining spheres in the other and parallel layer then if planes of intersection between the several spheres in both layers be formed there will result a double layer of hexagonal prisms united together by pyramidal bases formed of three rhombs and the rhombs and the sides of the hexagonal prisms will have every angle identically the same with the best measurements which have been made of the cells of the hive bee But I hear from Prof Wyman who has made numerous careful measurements that the accuracy of the workmanship of the bee has been greatly exaggerated so much so that whatever the typical form of the cell may be it is rarely if ever realised

Hence we may safely conclude that, if we could slightly modify the instincts already possessed by the Melipona and in themselves not very wonderful this bee would make a structure as wonderfully perfect as that of the hive bee We must suppose that Melipona to have the power of forming her cells truly spherical and of equal sizes and this would not be very surprising seeing that she already does so to a certain extent and seeing what perfectly cylindrical burrows many insects make in wood apparently by turning round on a fixed point. We must suppose the Melipona to arrange her cells in level layers, as she already does her cylindrical cells and we must further suppose and this is the greatest difficulty that she can somehow judge accurately at what distance to stand from her fellow labourers when several are making their spheres but she is already so far enabled to judge of distance that she always describes her spheres so as to intersect to a certain extent and then she unites the points of intersection by perfectly flat surfaces By such modifications of instincts which in themselves are not very wonderful —hardly more wonderful than those which guide a bird to make its nest,— I believe that the hive bee has acquired through natural selection her inimitable architectural powers

But this theory can be tested by experiment. Following the example of Mr Tegetmeier I separated two combs and put between them a long thick rectangular strip of wax the bees instantly began to excavate minute circular pits in it [illegible] appearing to the eye perfectly true or parts of a sphere and of about the diameter of a cell It was most interesting to observe that wherever several bees had begun to excavate these basins near together they had begun their work at such a distance from each other that by the time the basins had acquired the above-stated width (i e about the width of an ordinary cell) and were in depth about one sixth of the diameter of the sphere of which they formed a part the rims of the basins intersected or broke into each other As soon as this occurred the bees ceased to excavate and began to build up flat walls of wax on the lines of intersection between the basins so that each hexagonal prism was built upon the scalloped edge of a smooth basin instead of on the straight edges of a three sided pyramid as in the case of ordinary cells

I then put into the hive instead of a thick rectangular piece of wax a thin and narrow knife edged ridge coloured with vermilion The bees instantly began on both sides to excavate little basins near to each other in the same way as before but the ridge of wax was so thin that the bottoms of the basins if they had been excavated to the same depth as in the former experiment would have broken into each other from the opposite sides The bees, however did not suffer this to happen and they stopped their excavations in due time so that the basins, as soon as they had been a little deepened came to have flat bases and these flat bases, formed by thin little plates of the vermilion wax left ungnawed were situ

an country and let s further suppose that the community h ed thro gh th winter and consequently required a store of h ney there can in this case be no d ubt that it would be an ad antag to our imaginary humble-bee if a sl ght modification in h r instincts led her to make her waxen cells near to th so as to intersect a little for a wall in comm n even to tw adjoinin cells w uld sa some little labour and wax. Hence t w uld co tinuall be more and more ad antageous t our humble-bees, if they were to mak their cells m re and more regular neare togeth and aggreg ted int mass, like th cells f th M lipona f in this case large part of th bounding sur face of each cell w uld serv to bound th adjo nin cells, and m ch labour and wax would be sa ed. Again, from th sam cause, t ould be ad anta eous to th M lipona, if sh were t mak her cells close tog th r and more regular in ery w y than t present for then, as w ha seen, the sph rical surfaces

natural selection could not lead f th comb of th hi e-bee, as far as w can see, is abso l tel perfect in eco omisin labour and wax.

Thus, as I beli e, the most w nderful of all known instincts, that of th hi -bee can be explained by natural selection havin tak n ad antag of umerous, successi slight mod fications of simple in tincts natural selection ha in by slow d rees, m re and m re perfect l led the bees to sweep equal spheres at gi en distance from each th in d uble la er and to build p and ca ate th wax alon the planes of int rsectio th bees, of co se no more knowin that they swept their spheres at one particular distance from each ther than the kn w what are th se ral angles of the hexagonal prisms and of th basal rhomb c plates the moti power of the proc ess of nat ral selectio ha ing been th co structio of cells of d stre th and of the proper size and shape f the larv thus bei g ff ted th th gre test possible econom of labou and wax that nd idual arm which th mad the best cells w th least labour and least aste of honey in th secretion of wax, ha ing succeeded best, and h ving transmitted their newly-acquired economical instincts to new warms, which in their turn will ha had the best chance of succeeding in the struggle for existence.

Objections to the Theory of Natural Selec t on as applied to Instincts Neuter and Sterile Insects

It the stru multaneous and acc oth r as a modificati n in th one with t an immed te correspondin chang in the ther w uld ha e been f tal. Th f rce of this objection rests entirely on the assumptio th t th changes in the instincts and tructure are abrupt. To take as an illustrati n th case f th larger titm use (*Parus maj*) all ded to in pre ious chapter this bird oft n holds the seeds of th yew between ts feet on a branch, and hamm rs with ts beak till t g ts t the kern l. N w what special difficulty w uld th re b in natural selecti n preservin all the sli ht indi id al vari t on in th sh pe of the beak, which w re bett r and better ad pted to break pen th seeds, until a beak was f rmed, as w ll constructed f this purpose as that f the nuthatch, at the sam tim that hab t, o compulsion, spo taneous variati ns of taste led th bird to becom m re and m re of a seed-eater In this case th beak is supposed to be slowly modified by natural selectio sub-

with th beak, from an oth r unkn wn cause and t is n t mprobabl that uch lar r feet w uld lead the bird to climb m re and more until t acquired th remarkable climb ng instinct and pow f the th tch In thi case a grad al hang of tru ture is pposed to lead to changed instincts hab ts. T tak on more case f w instincts are more remark abl than that which l ad th swift of th East rn Islands t mak ts nest wholly f in spissated sal a. Som birds build th ir nests of mud beli ved to be m ist ned with sal and of th wifts of N rth Am rica makes ts nest (as I ha see) of ticks a gl tinated with sal a, and ev n with flakes f this ub tance. Is t then ry mprobable th t th natural selectio of individual swifts, which secreted m re and more sal a, hould t la t produce specie with instincts leadin t to neglect ther materials, and to make its nest clusi ly of n pissated sal a And so in other cases. It must, h wev be admitted that in many instances we cannot co jecture wh ther t was instinct r tructure which first varied.

the basal rhomboidal plates are thicker nearly in the proportion of three to two having a mean thickness from twenty one measurements of $\frac{1}{229}$ of an inch By the above singular manner of building strength is continually given to the comb with the utmost ultimate economy of wax

It seems at first to add to the difficulty of understanding how the cells are made that a multitude of bees all wo l r one bee

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ou v uuals work even at the commencement of the first cell I was able practically to show this fact by covering the edges of the hexagonal walls of a single cell or the extreme margin of the circumferential rim of a growing comb with an extremel tl l l

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orush—by atoms of the coloured wax having been taken from the spot on which it had been placed and worked into the growing edges of the cells all round The work of construction seems to be a sort of balance struck between many bees all instinctively standing at the same relative distance from each other all trying to sweep equal spheres an l then building up or leaving ungnawed the planes of intersection between these spheres It was really curious to note in cases of difficulty as when two pieces of comb met v

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apc which they had at first rejected

When bees have a place on which they can stand in their proper positions for working — for instance on a slip of wood placed di ectly under the middle of a comb growing dow nwards so that the comb has to be built over one face of the slip—in this case the bees can lay the foundations of one wall of a new hexagon in its strictly proper place projecting beyond the other completed cells It suffices that the bees should be enabled to stand at their proper relative distances from each other and from the walls of the last con l l cell

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of a cell till a large part both of that cell and of the adjoining cells has been built Ti is c pac ity in bees of laying dow n under certain circumstances a rough wall in its proper place between two just-commenced cells, is important as it bears on a fact which seems at first subversive of the foregoing theory namely that the cells on the extreme margin of wasp-combs are sometimes strictly hexagonal but I have not space here to enter on this subject Nor does there seem to me any great difficulty in a single insect (as in the case of a queen wa p) making hexagonal cells if she were to work alternately on the inside and outside of two or three cells commenced at the same time always standing at the proper relative distance from the parts of the cells just begun sweeping spheres or cylinders, and building up intermediate planes

As natural selection acts only by the accumulation of slight modifications of structure or instinct each profitable to the individual under its conditions of life it may reasonably be asked how a long and graduated succession of modified architectural instincts all tending towards the present perfect plan of construction could have profited the progenitors of the hive bee? I think the answer is not difficult cells constructed like those of the bee or the wa p gain in strength an l save much in labour and space and in the materials of which they are constructed With re pect to the formation of wax it is known that bees are often hard pre sed to get sufficient nectar and I am informed by Mr Tegetmeier that it has been experimentally proved tl at from tv elve to fifteen pounds of lry sugar are consumed by a hive of bees for the s cretion of a pound of wax so that a prodigious quantity of flui l nectar must be collected and consumed by the bees in a hive for the secretion of the wax necessary for the c nstruction of their combs Moreover many bees have to remain idle f r many days during the process of secreti n A large store of h ney is indi pensal le to support a large stock of l ees luring the winter and the security of th hive i know n mainly to lepen l on a large numl er of bees being supported Hence th saving of vax by largely saving honey and tl e time con i med in collecting the honey mu t be an important elen ent of success to any family of bees Of course the success of the peci s may be dej endent on the number of its enc ne o

neu v l ether a l e all l t y our humi le bees could xist in la g numbers in

ants, and the d ble t rile plants w th the pe t rs f th sam comm nity As tl the

ne ters having th ad antageo s modifica t ns, all the ne te s lt mately came to be thu character sed Accord g to th s v ew w o lt occas ally to fi d in tl e s m n st

servi ceabl d II ce w m y concl de that l gl t mod ficat ns of truct re r f nstinct corr l ted w th th st ril c d t of certain m mb rs f the comm nity h ve proved ad antageo s co seq tly the f tile males and

t m s, u til th t p od g u m nt f d ff ce b twee th fert le d t ril fem les f tl e same spec l as be produced which we see in many soc al insects.

both larg and mall r num ous, wh l t

B t w l e t as yet to ched on th acme f tl e d fficulty m ly the fact th t the n t f se al n ts d ff r t o ly from tl f t le f m les and males, b t f m ach tl som t mes t an almost in red ble d g ee and are tl di ided to two en thre cast Tl astes, m reo er d t commo ly g d t t ach th b t perf ctly w ll d f d b g as disti t f m ach tl c as ar

and th pec s, as M F S n th has b s ed the l g r w ker l ve mple yes (ocelli) which tho l mall c n b pl ly d t ngi l ed whe as the mall w k s h e tl r oc lli rudim tary Having caref lly d ssected se l pec m ns f tl se o k s I can affirm th t the y are far more rud m t ry in the small w rker th n can b accounted f r merely by tl r p po ti nally l sser ize d I fully b l eve tl gl I dare n t assert so po ti ly that the w k of t med te h tl eir ocell n n exactly t rmed t c d t n So tl t l we h tw bod es f t l w kers in th sam t

t C yptocerus, the w k l e cast al carry w nd rf l sort f h ld tl l ads, th use f wh l t ukn tl M an Myrmecocy t s, tl e o k rs f ast l th t th y ar fed by th k rs f anotl cast and th y h e m ly d loped bd m wl cl cretes sort f h ply g tl place f tl t reted by tl y l d s, tl d mesti cattl as tl y may be called which ur European ants guard and imp ison.

ad l g th t f th m ll r w k l ad been tl most usef l t the community and tl o m le and f mal had b n c t ally selected wl ch p od ce l mo e and m f tl m ll w kers, nt l all the work re n tl cond t we hould th ha e l l p c f ant w th ute s in ly the ame co d t as tl se f Myrm ca F the w k rs f My m c h v t e en rudiment f ocell th gh tl ale and f male ant f th g nu h w ll-d l ped ocelli

It ll indeed be th ght th t I h rwee g co fid ce tl prin pl f nat al select n, wl en I d t adm t tl t cl nd rf l and w ll-establisl ed facts t o e an h lat th theory I th mpl ase of tr nsects all of aste wl h, as I belie ha be re d red d ff re t from th f rt le m l s and f mal tl ro gh nat al se lection, m concl l from th an al gy f rd nary ar tio s, that th uccess l ght, profitable mod fic t ns l d t f rst arise in all the t rs th sam est l t in som f w k and that by tl rv l of tl com m t th f mal which prod ced most

I m y g o th r case so co f de tly d l I pect occas lly to find grad ti ns f m po tant stru t es b t ee the d ffere t cast f n t s in th same peci th t I gladly ail d myself f Mr F Sm th ff f n m ro pecimens from tl same t f th dri ant (A mma) f West Af ca. The read will pe hap best pprec te th am nt

No doubt many instincts of very difficult explanation could be opposed to the theory of natural selection—case in which we cannot see how an instinct could have originated cases in which no intermediate gradations are known to exist cases of instincts of such tri fling importance that they could hardly have been acted on by natural selection cases of instincts almost identically the same in ani mals so remote in the scale of nature that we cannot account for their similarit by inheri tance from a common progenitor and conse quently must believe that they were independ ently acquired through natural selection I will not here enter on these several cases, but

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the neuters or sterile females in insect-com munities for these neuters often differ widely in instinct and in structure from both the

great length but I will here take only a single case that of working or sterile ants How the workers have been rendered sterile is a diffi culty but not much greater than that of any other striking modification of structure for it can be shown that some insects and other articulate animals in a state of nature occa ionally become sterile and if such insects had been social and it had been profitable to the community that a number should have been annually born capable of work but incapable of procreation I can see no especial difficulty in this having been effected through natural election But I must pass over this prelim inary difficulty The great difficulty lies in the working ants differing widely from both the males and the fertile females in structure as in the shape of the thorax and in being destitute of wings and sometimes of eyes and in in stinct. As far as instinct alone is concerned the wonderful difference in this respect between the workers and the perfect females would have been better exemplified by the hive bee If a working ant or other neuter insect had been an ordinary animal I should have un he itatingly assumed that all its characters had been slowly acquired through natural selection namely by individuals having been born with slight profitable modifications which were inherited by the offspring and that these again vari d and again were selected a d so onwards But with the working ant we have an insect differing greatly from its parents, yet absolutely sterile so that it could never have transmitted successively acquired modifica tions of structure or instinct to its progeny It may well be asked how is it possible to re concile this case with the theory of natural selection?

First let it be remembered that we have innumerable instances both in our domestic productions and in those in a state of nature of all sorts of differences of inherited structure which are correlated with certain ages, and with either sex We have differences correlated not only with one sex but with that short period when the reproductive system is active as in the nuptial plumage of many birds, and in the hooked jaws of the male salmon We have even slight differences in the horns of different breeds of cattle in relation to an artificially im perfect state of the male sex for oxen of cer tain breeds have longer horns than the oxen of other breeds, relatively to the length of the horns in both the bulls and cows of these same breeds. Hence I can see no great difficulty in any character becoming correlated with the sterile condition of certain members of insect communities the difficulty lies in understand ing how such correlated modifications of struc ture could have been slowly accumulated by natural selection

This difficulty though appearing insuper able is lessened or as I believe disappears, when it is remembered that selection may be applied to the family as well as to the indi vidual and may thus gain the desired end Breeders of cattle wish the flesh and fat to be

has succeeded Such faith may be placed in the power of selection that a breed of cattle al ways yielding oxen with extraordinarily long horns could it is probable, be formed by care fully watching which individual bulls and cow when matched produced oxen with the longest horns and yet no ox would ever have propagated its kind Here is a better and real illustration according to M Verlot, some varieties of the double annual Stock from hav ing been long and carefully selected to the right degree always produce a large propor tion of seedlings bearing double and quite sterile flowers but they likewise yield some single and fertil plants. These latter by which alone the va ety can be propagated may be compared with the fert le male and female

This theory is also stre gtl e ed by some f ı f ts regard t instincts as by
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tand the pri cipl of inheritance how t is th t tl e thrush of trop cal So th Am ca lin ts est w th m d in the sam pec liar mann as does our British thrush l w t is that the hornb lls f Africa and Ind a h e th sam traordinary nstinct f plasteri up and mpriso ing th females in a h l in a tree th ly a mall h le l ft th plaster through hich th males feed them and th ir y un when hatched how t is th t th m le wrens (Troglodyte) of No th Am ca bu ld cock nests, to roost in, l k the m le f u k tty wrens,— h b t wh lly unlike th t f any oth kn wn b rd Finally t may not be a log cal ded ct but t my imagin t n it is far more satisfact y to look t s h in tincts as the y u uckoo jecting its foste brothers,—ants making l es,—th lar æ of i hn mon dæ feed g w thin the l e bod es of caterp llars,— t as specially n l wed or r ted inst ncts but as small con seq ce f on g n ral law leadi to the ad ancement f all o gan b in s,—namely m lt ply ary l t the tro gest l e and the weake t di

of difference in these workers by my giving not the actual measurements but a strictly accurate illustration the difference was the same as if we were to see a set of workmen building a house of whom many were five feet four inches high and many sixteen feet high but we must in addition suppose that the larger workmen had heads four instead of three times as big as those of the smaller men and jaws nearly five times as big The jaws moreover of the working [illegible] al [illegible] e

[illegible] is that though the workers can be grouped into castes of different size yet they graduate insensibly into each other as does the widely different structure of their jaws I speak confidently on this latter point, as Sir J Lubbock made drawings for me with the camera lucida of the jaws which I dis sected from the workers of the several sizes Mr Bates in his interesting *Naturalist on the Ama ons* has described analogous cases

With these facts before me I believe that natural selection by acting on the fertile ants or parents could form a pecies which should regularly produce neuters all of large size with one form of jaw or all of small size with widely different jaws or lastly and this is the greatest difficulty one set of workers of one size and structure and simultaneously another set of workers of a different size and structure —a graduated series having first been formed as in the case of the driver ant and then the ex treme forms having been prod [illegible] greater [illegible] val of [illegible] none [illegible] duced [illegible] given by Mr Wallace of the equally complex case of certain Malayan butterflies regularly appear ing under two or even three distinct female forms and by Fritz Müller of certain Brazil ian crustaceans likewise appearing under two widely distinct male forms. But this subject need not here be di cussed

I have now explained how as I believe the wonderful fact of two distinctly defined castes of sterile workers existing in the same nest, both widely different from each other and from their parents, has originated We can see how useful their production may have been to a social community of ants, on the same prin ciple that the division of labour is useful to civilised man Ants, however work by in herited instincts and by inherited organs or tools whilst man works by acquired knowledge and manufactured instruments. But I must confess that, with all my faith in natural se lection I should never have anticipated that this principle could have been efficient in so high a degree had not the case of these neuter insects led me to this conclusion I have, there fore discussed this case at some little but wholly insufficient length in order to show the power of natural selection and likewise be cause this is by far the most serious pecial difficulty which my theory has encountered. The case, also is very interesting as it proves that with animals, as with plants, any amount of modification may be effected by the ac cumulation of numerous, slight, spontaneous variations, which are in any way profitable without exercise or habit having been brought into play For peculiar habits confined to the workers or sterile females however long they might be followed could not possibly affect the males and fertile females which alone leave descendants I am surprised that no one has hitherto advanced this demonstrative case of neuter insects against the well known doctrine of inherited habit, as advanced by Lamarck

Summary

I have endeavoured in this chapter briefly to show that the mental qualities of our dome tic animals vary and that the variations are in herited Still more briefly I have attempted to show that instincts vary slightly in a state of nature No one will dispute that instincts are of the highest importance to each animal Therefore there is no real difficulty under changing conditions of life in natural selecti n accumulating to any extent slight modifica tions of instinct which are in any way useful. In many cases habit or use and di use have probably come into play I do not preten l that the facts given in this chapter strengthen in any great degree my theory but none f the cases of difficulty to the best of my judgment, annihilate it On the other hand the fact that instincts are not always absolutely perfect and are liable to mistakes —that no instinct can be shown to have been produced for the good of other animals, though animals take advantage of the instincts of others —that the can n in natural history of *Natu a non facit alt m* is applicable to in tin ts as well as to corporeal structure and is plainly explicable on the fore going vie s, but is oth rwise inexplical le — all tend to corroborate the theory of natural selection

Th s tl eory is also trengthe ed by some f w l fact regard t nstincts as by t

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wh n hatched how t is that th male wrens (Troglodytes) of No th Am r a b ld cock nests, to roo t in l k the m le f u k tty wrens —a h b t wh lly unl ke th t of any oth r k wn b rd Finally t m y not be log cal ded ct but to my imagin t n it is far m e satisfactory to look at su h in tincts as the you g uckoo ject g t f s- te b thers,—ants making la es,—th lar væ of i hn mo dæ f ed ng within the l e bod f caterp llars,—n t as pecially n d ed r cre ted inst cts but as small seq ce f on g n ral law lead ng to the ad ancem nt f all o gan b ngs,—n mely m lt ply ry l t the trong t l e and the weake t die.

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I o ~ p u nto castes of different size yet they graduate insensibly into each other as does the widely different structure of their jaws I peak confidently on this latter point as Sir J Lubbock made drawings for me with the camera lucida of the jaws which I dis sected from the workers of the several sizes Mr Bates in his interesting *Naturalist on the Ama_ons* has described analogous cases

With these facts before me I believe that natural selection by acting on the fertile ants or parents could form a pecies which should regularly produce neuters all of large size with one form of jaw or all of small size with widely different jaws or lastly and this is the greatest difficulty one set of workers of one size and structure and simultaneously another set of workers of a different size and structure —a graduated series having first been formed as in the case of the driver ant and then the ex treme forms having been prod ' ater

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~ ~ ~ g ven by Mr Wallace of the equally complex case of certain Malayan butterflies regularly appear ing under two or even three distinct female forms and by Fritz Müller of certain Brazil ian crustaceans likewise appearing under two widely distinct male forms B t tl

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or sterile workers existing in the same nest, both widely different from each other and from their parents, has originated We can see how useful their production may have been to a social community of ants, on the same prin ciple that the division of labour is useful to civilised man Ants, however work by in herited instincts and by inherited organ or tools whilst man works by acquired knowl dge and manufactured instruments. But I must confess that, with all my faith in natural se lection I should never have anticipated that this principle could have been efficient in so high a degree had not the case of these neuter insects led me to this conclusion I have, there fore discussed this case at some little but wholly insufficient length in order to show the power of natural selection and likewise be cause this is by far the most serious pecial difficulty which my theory has encountered The case also is very interesting as it proves that with animals as with plants any amount of modification may be effected by the ac cumulation of numerous slight, spontaneous variations which are in any way profitable without exercise or habit having been brought into play For peculiar habits confined to the workers or sterile females however long they might be followed could not possibly affect the males and fertile females which alone leave descendants I am surprised that no one has hitherto advanced this demonstrative case of neuter insects against the well known doctrine of inherited habit as advanced by Lamarck.

Summary

I have endeavoured in this chapter briefly to show that the mental qualities of our dome tic animals vary and that the variations are in herited Still more briefly I have attempted to show that instincts vary slightly in a state of nature No one will dispute that instincts are of the highest importance to each animal Therefore there is no real difficulty under changing conditions of life in natural selecti n accumulating to any extent slight modifica tions of instinct which are in any way useful In many cases habit or use and disuse have probably come into play I do not preten l tl at the facts given in this chap ter strengtl en in any great degree my theory but none of the cases of difficulty to the best of my judgm nt, annihilate it On the other hand th fact tl at instincts are not always absolutely perfect and are liable to mistakes —*that no*

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nat ral history of N *tura non facit altum* is applicable to in tincts as well as to corporeal structure and is plainly exj licable on tl fore going view s but is otl erwise inexpl cable — all tend to corroborate tl e theory of natural selection

able statement repeatedly mad by Gartn r namel that if en the less f rtile hybrids be artificiall f rtilised with hybrid pollen f the m k nd their fertility n twithstandin the

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ner arr ed at diam trically pposite conclu sions in regard to som of th ery same f rms. It is also most instructi e to compare—b t I ha not space here to ent r on d tails—the evid nce ad anced by ou best botanists on the question wh the certain doubtf l f rms should be ranked as pec s ari ties, with the evidence from f rtilit add ced by differ t hybridisers, by the sam observer from experiments mad during diff rent y ars. It can thus be sh wn that th steril ty nor f ti.t affords any certain distinctio between species and arieties. The id nce from this *source graduates w y* and is d btful n th sam degree as is th idence d ri ed from ther constit tional and tructural diff rences.

In regard to the sterility of h brids in suc cess generations though Gartn was n abled t rear som h brids, carefully guarding them from cross w th eithe p re parent, for six or se en, and in ne case f t n g n ra tions, y t he asserts positi el that their fertil ty ne er increases, b t generally decreases greatly and suddenly W th respect t this de crease t may first be noticed that hen any deviation in tructure or const t tio is com *mon to both parents, this often transm tted* in an mented d gree to the offspring, and both sexual elements in h brid plants are al ready affected in som degree B t I belie that thei fertility has been diminished in nearl all these cases by an independent cause namel by too close interbreeding. I ha mad so many xperime ts and col ected so many facts, showing the one hand that an occasional cross w th distinct ndi idual or ariet increases th vigour and f rtilit of the offspring, and the th hand that ery close interbreeding lessens their gour and f rtility *that I cannot doubt the correct ess of this con*lusion. H brids are seldom raised b xperimentalists in great mbers and as the parent pecies, or other allied h brids, g erall grow in the sam garden, the visits of insects must be carefully pre ted during the flo ering season hence hybrids, if left t themsel es, d generally be f rtilised during each genera tion by pollen from the sam flower and this ould probably be injurious to thei fertilit already lessened by their hybrid origin. I am strengthened in this con ection by remark

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tion, pollen is as often taken by chance (as I know from my wn experi nce) from th an thers of anoth fl w r as from the anth rs of the fl w tself which is to be f rtilised so that cross between two fl w rs, th u h probably oft n th sam plant, w uld be thus ef fected. M reo when er complicated ex perim nts are in progress, so careful an ob serv as Gartn r w uld have castrated his hybrids, and this w uld ha ns red in each g ration a cross w th pollen from a distinct fl w r the from the sam plant r from an other plant of th sam hybrid nature And thus, th trange fact f an increase of f rtility in th successi e gen rati ns of *art ficially fer tilised* hybrids, in contrast with those spon taneously self fertilised, may as I beli be accounted for by too close interbreeding, hav ing been a ided.

N w l t us turn to th results arri ed t by a third most xperi nced h bridiser namel the Hon. and R W Herbert. H is as m phatic in his conclusi that som hybrids are perfectly f rtile—as f rtile as th pure parent *species—as are Kolreut r and Gartn r* that som d gree of sterility between disti ct spe cies is a uni rsal law of nature H xperi mented n som of the v ry sam species as did Gartne Th diff rence in th result may I think, be in part accounted f by Herbert great horticultural skill, and by h s having hot houses t his command. Of his many important tatem nts I will h re gi only a single o e as an exampl nam ly that ry ule in a pod of *Cri m capense* f tilised by *C revolutum* prod ced a plant, which I ne er saw to occur in case of its natural fecundation." So that here w ha e perfect or en more than comm nly perfect f rtility in first cross between two distinct species

This case of th *Cri m* leads m to ref to singular fact, nam ly that indi idual plants *of certain species of Lobelia, Verbascum* and *Passiflora*, can easily be fertilised by pollen from a distinct pecies, b t not by pollen from th sam plant, though this pollen can b pro ed to be perfectly sound by fertilisi g other plants or species. In the genus *Hippeas trum*, in *Corydalis* as shown by Professo

CHAPTER IX

HYBRIDISM

THE view commonly entertained by naturalists is that species when intercrossed have been pecially endowed with sterility in order to prevent their confusion This view certainly seems at first highly probable for pecies living together could hardly have been kept distinct had they been capable of freely crossing The subject is in many ways important for us more especially as the sterility of species when first crossed and that of their hybrid offspring cannot have been acquired as I shall show by the preservation of successive profitable degrees of sterility It is an incidental result of differences in the reproductive systems of the parent pecies

In treating this subject two classes of facts to a large extent fundamentally different have generally been confounded namely the sterility of pecies when first crossed and the sterility of the hybrids produced from them

Pure species have of course their organs of reproduction in a perfect condition yet when intercrossed they produce either few or no offspring Hybrids on the other hand have their reproductive organs functionally impotent as may be clearly seen in the state of the male element in both plants and animals though the formative organs themselves are perfect in structure as far as the microscope reveals In the first case the two sexual elements which go to form the embryo are perfect in the second case they are either not at all developed or are imperfectly developed This distinction is important, when the cause of the sterility which is common to the two cases has to be considered The distinction probably has been slurred over owing to the sterility in both cases being looked on as a special endowment beyond the province of our reasoning powers

The fertility of varieties that is of the forms known or believed to be descended from common parents, when crossed and likewise the fertility of their mongrel offspring is with reference to my theory of equal importance with the sterility of species for it seems to make a broad and clear distinction between varieties and species.

Degrees of Sterility —First for the sterility of species when crossed and of their hybrid offspring It is impossible to study the several memoirs and works of those two conscientious and admirable observers, Kolreuter and Gärtner who almost devoted their lives to this

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he cuts the knot for in ten cases in which he found two forms considered by most authors as distinct pecies quite fertile together he unhesitatingly ranks them as varieties. Gartner also makes the rule equally universal and he disputes the entire fertility of Kolreuter s ten cases But in these and in many other cases Gartner is obliged carefully to count the seeds in order to show that there is any degree of sterility He always compares the maximum number of seed produced by two species when first crossed and the maximum produced by their hybrid offspring with the average number produced by both pure parent species in a state of nature But causes of serious error here intervene a plant to be hybridised must be castrated and what is often more important must be secluded in order to prevent pollen being brought to it by insects from other plants Nearly all the plants experimented on by Gartner were potted and were kept in a chamber in his house That these processes are often injurious to the fertility of a plant cannot be doubted for Gartner gives in his table about a score of cases of plants which he castrated and artificially fertilised with their own pollen and (excluding all cases such as the Leguminosæ in which there is an acknowledged difficulty in the manipulation) half of these twenty plants had their fertility in some degree impaired Moreover as Gartner repeatedly crossed some forms such as the common red and blue pimpernels (*Anagallis arvensis* and *c ... lea*) which the best botanists rank as varieties and found them absolutely sterile we may doubt whether many pecies are really so sterile when intercrossed as he believed

It is certain on the one hand that the sterility of various pecies when crossed is so different in degree and graduates away so insensibly and on the other hand that the fertility of pure species is so easily affected by various circumstances that for all practical

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frequent ill effects from manip lation, sometim s decidedly increases, and goes on increasing \ w in th process of artificial f rtilisa tion, pollen is as often taken by chance (as I k w from my own expri nce) from th an

oft n n the same plant, w uld be thus et fected M reo when r complicated ex periments are in progress, so careful an observ r as Gartn r w ld ha ca trated his hybrids, and this wo ld ha e ns red each ge rati a cross w th pollen from a distinct fl e the from th sam plant or from an tl plant of th sam hybrid nature \nd

sions in regard to some of the ery sam f rms. It is also most instruct to compare—b t I ha not pace h re to t d tails—th idence ad anced by our best botanists on th q estion wh ther cert n d btf l f rms should be ranked as spec e ari ties, with the id nce from f rtilit adduced by diff ent hybridisers, b y th sam observer from xperiments mad d ring d ff re t ars. It can th be sh wn that th t rility no f tilit aff rds any certain distinction bet een species and arieties. Th e id ce from this source graduates w y and is do btful th sam d gree as is the evid ce d ri ed from other constit tional and tru tural diff rences.

I re ard to th steril ty of hybrids in successi g rati ns though Gart was n l kd t rear some h brids, carefully guarding them from cross w th the pure pare t, for si or se en, and in case f r t g era tions, y t h asserts posit l that tl ir f rtil ty ncreases, b t gen rall decreases gre tly and sudd nly W th respect t this decrease t may first be ticed th t whe any d iation in tructure const t ti n is com mon t both pare ts, this often transm tted an gm ted d gree to tl ff pring and both se ual leme ts hybrid plants are al ready affected in som d gree B t I beli that th f rtility has bee d minished in nearl all these cases by an independ t cause nam l by too close int rbreed g. I ha mad so many xperim ts and collected so man facts, showing th hand that an occasional cross w th dist t nd id al ariet increases th gour and f rtil t f th offspring, and th th hand that ry close int rbreeding lessens tl gou and f rtility that I annot d bt th correct ess of this conlusion. H brid are seldom ra sed l y xperi mentalists in gre t mbers and as th pare t pecies, or othe allied h brids, g erall grow in the sam garden, th isits of insects must be carefully pre ted during the fl ring season hence hybrids, if l ft t themsel es, ill generally be f rtilised during each g era tion b pollen from the sam flower and this ould probably be injuriou to thei fertility already lessened by their hybrid origin. I am trengthened in this con ction by remark

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Now let us turn t the results arri ed at by third most xperi nced h brid ser namel the H n. and R W Herbert. He s as m ph tic in his conclusi th t som h b ids are perfectly f rtil —as f rtile as th pure pare t pecies—as are K lre t r and Gartn th t som degree f t rility between dist ct pe c is a uni rsal law f nature H experi m ted on som f the ry sam species as did Gartn Th d ff re ce th results may I think, be in part accounted for by H rb rt gre t h rticult ral skill, and by h s ha ing h t h uses t his command Of his many mportant tat m ts I will l gi nly single on as an example, namely that ry ul n a pod of Cri m c pense f tilised by C d t m prod ced plant, which I saw to occu in a case of its natur l fecund tion. So that h re w ha perfect r en m re than comm nly perfect f rtility in first cross between tw distinct pecies This case of th Cri m leads m to ref to si gular fact, nam ly that indi idual plants f certain spec es f Lobelia, V erbasc m and I as fl ra, can asily be f rtilised by poll n from distinct pecies, b t not by poll n from th sam plant, though this pollen can be pro ed to be perfectly sound by fertilising th plants o species. In th genus Hippeastrum, in C rydalis as sh wn by Professor

Hildebrand in various orchids as shown by Mr Scott and Fritz Müller all the individuals are in this peculiar condition So that with some pecies certain abnormal individuals and in other species all the individuals can actually be hybridised much more readily than they can be fertilised by pollen from the same individual plant! To give one instance a bulb of *Hippeastrum aulicum* produced four flowers three were fertilised by Herbert with their own pollen and the fourth was subsequently fertilised by the pollen of a compound hybrid descended from three distinct species the result was that the ovaries of the three first flowers soon ceased to grow and after a few days perished entirely whereas the pod impregnated by the pollen of the hybrid made vigorous growth and rapid progress to maturity and bore good seed which vegetated freely Mr Herbert tried similar experiments during many years and always with the same result These cases serve to show on what slight and mysterious causes the lesser or greater fertility of a species sometimes depends

The practical experiments of horticulturists though not made with scientific precision deserve some notice It is notorious in how complicated a manner the pecies of *Pela gonium Fuchsia Calceolaria Petunia Rhodod nd on* &c have been crossed yet many of the e hy brids seed freely For instance Herl rt asserts that a hybrid from *Calceolaria integrifolia* and *plantaginea* species most widely dissimilar in general habit reproduces itself as perfectly as if it had been a natural pecies from the mountains of Chili I have taken some pains *to ascertain the degree of fertility of ome of* the complex crosses of rhododendrons and I am assured that many of them are p rfe tly fertile Mr C Noble for in tance infor us me that he raises stocks for grafting from a hybrid between *Rhod ponticum* and *catawbien e* and that this hybrid seeds as freely as it is possible to imagine Had hybrids when fairly treated always gone on decreasing in fertility in each successive generation as Gartner believed to be the case the fact would have been notorious to nurserymen Horticulturists raise large beds of the same hybrid and such alone are fairly treated for by insect agency the several individuals are allowed to ... ely ... e of ... one ... ncy of insect agency by exami ing the flow rs of the more sterile kinds of hybrid rhod den drons which produce no pollen for he will find on their stigmas plenty of pollen brought from other flowers

In regard to animal much fewer experiments have been carefully tried th ...

... en we may infer that animals more widely distinct in the scale of nature can be crossed more easily than in the case of plants but the hybrids themselves are I think more sterile It should however be borne in mind that owing to few animals breeding freely under confinement few experiments have been fairly tried for instance the canary bird has been crossed with nine di tinct species of finches but as not one of these breeds freely in confinement we have no right to expect that the first crosses between them and the canary or that their hybrids should be perfectl f ...

... br i nave been raised at the same time from different parents so as to avoid the ill effects of close interbreeding On the contrary brothers and sisters have usually been crossed in each succe sive generation in opposition to the constantly rej eate l a lmonition of every bree ler And in thi case it is not at all surprisi g th ...

... ven authenticated cases of perfectly fertile *hybrid animals I hav re* ...

... y rf ectly fertile M Quatrefag s t tes that the hybri ls from two moths (*Bombyx cynthia* and *arrindia*) w re proved in Paris to be f rtile inte se for eigl t g nerations. It has lately been a serted that two such di tinct species as the har and rabbit when they can be got to br ed tog ther produce off pring which are highly fe t l w l en crossed with one of the parent pecies The hybrids from the common and Chi e e gee (*A cygnoides*) pecies which are so diff r nt that they are generally ranked in di tinct genera, have oft n bred in this count y with eith r pure par nt, and in one ngle in ta ... l

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birds h raised n l ss than ght hybrids (grandchildren f th p re geese) from o est. I India, ho tl se cross-b ed geese mu t be far m re fert l f I m as. red by t min tly c pabl j dges, nam ly Mr Bl th and Capt. H tton, that wl l flocks of tl ese crossed geese are k pt ar *parts* f l co try and as tl y are k pt f profit l

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t in man cases tl y ar d sce ded from tw *more* ld spec es. From th fact must conclud th that th boriginal pare t peci s t first prod ced pe fectly f rt l hy brids, r that th hybrid l seq entl *reared* und r d mest catio b xam q t *f rtil* This latt alt rnati wl h as first propo ded b Pallas, seems by far th m t prob bl d an, indeed h rdly be d bted It s, f n tai e almost certain that d g are d sce l d from se al w ld tock y t, w tl pe l j the j t f tai d g us d be d gs f So th A ca, all are q t f rt l t geth b t anal gy makes m gre tl d bt h th th se eral abori al pec s ld t first ha freel l red t g tl and

and commo cattl re *t* perfectly f t l and from th bse t ns by Rütim th mportant o teolog l d ff re ces, ll as from th se b M Bl tl tl d f f re ce hab ts, e onst t t n, & tl ese t form m t be reg l d as good an l dist nct pecies. Tl sam re k m y be t led t tl tw l f race f tl p g W m t tl ref re tl g p tl bel f f tl sal t ril t of j wl ro sed must b k t tl is t ril ty an mals, t as an nd l t le l aract ri t l t as cap- ble of l rem d b l t cat n. F ll co nsid g all tl ascert ed facts th t rcross g f plant ar l at m ls, t ma be concluded that so d gree f t ril t both first crosses l l b ds, an tremel g al res lt l t that t cann t, und prese t t t f k l dge be co id red as absol t l rsal

Law gove n g tl St l ty f fi t Cros d f H b d

W ll now co sid l tl l re n d tail the la g rn g tl t ril t f first crosses

and f h brids. Our cl ef object will be to see wh tl r r n t these law ind cat tl t pec es h been pecially end wed with this qu l ty m rde t pre ent th r crossing and bl nd g t th t t r co fus o Th foll wing co

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It l as been already rema ked th t th de gree f f rt l ty b th f first crosses and f l ybrids, grad te from ro t perfect fe t lity It s rprisi g m h w many curi us w y *thus grad t n can l e sho b t only*

fam l t rts no m e influ nce than so

sam g s, yi ld pe fect g d t on in the n mb r f seed prod ced p to arly com pl t r n qu t compl t f rt lity and as w l see ertain b mal case n to an ce *ff t l ty* bey nd th t wh ch th plant w pollen j rod ces. So n hyb ds th mselv s, th re are som wh h v r ha p od ced d prob bly n w ld prod ce w th tl poll of tl p re pare t a singl f rt l seed but in som f tl se case a first trace f f rtility m b d tected by th poll f f tl p re p t p e ca g th fl w f tl l b l t w th arl tl an t th rw se w ld l d n and th e ly w tl g f tl fl w w ll kn n to be a go l e t f rt l sat *From tl ex*

Tl hybrid sed from t pec wh ch re ry diffi lt to cross, and which arely l

which t j re pec s, as the g us l *bascum* be ted w th u al facil ty nd j rod ce m ro hybrid ff j n g y t tl se l yl rid re mark bly t ril On tl th hand th re re pec h h can be

crossed

for instance in *Dianthus* these two opposite cases occur

The fertility both of first crosses and of hybrids is more easily affected by unfavourable conditions than is that of pure species But the fertility of first crosses is likewise innately variable for it is not always the same in degree when the same two species are crossed under the same circumstances it depends in part upon the constitution of the individuals which happen to have been chosen for the experiment. So it is with hybrids for their degree of fertility is often found to differ greatly in the several individuals raised from seed out of the same capsule and exposed to the same conditions

y is meant, the ecies in struc ertility of first crosses, and of the h

between species ranked by systematists in distinct families and on the other hand by very closely allied species generally uniting with facility But the correspondence between systematic affinity and the facility of crossing is by no means strict A multitude of cases could be given of very closely allied species which will not unite or only with extreme difficulty and on the other hand of very distinct species which unite with the utmost facility In the same family there may be a genus as *Dianthus* in which very many species can most readily be crossed and another genus as *Silene* in which the most persevering efforts have failed to produce between extremely close species a single hybrid Even within the limits of the same genus we meet with this same difference for instance the many species of *Nicotiana* have been more largely crossed than the species of almost any other genus but Gartner found that *N acuminata* which is not a particularly distinct species obstinately failed to fertilise or to be fertilised by no less than eight other species of *Nicotiana* Many analogous facts could be given.

No one has been able to point out what kind or what amount of difference in any recognisable character is sufficient to prevent two species crossing It can be shown that plants most widely different in habit and general appearance and having strongly marked differences in every part of the flower even in the pollen in the fruit and in the cotyledons, can be crossed Annual

tes, can often be crossed with ease

By a reciprocal cross between two species, I mean the case for instance of a female ass being first crossed by a stallion and then a mare by a male ass these two species may then be said to have been reciprocally crossed There is often the widest possible difference in the facility of making reciprocal crosses Such cases are highly important for they prove that the capacity in any two species to cross is often completely independent of their systematic affinity that is of any difference in their structure or constitution excepting in their reproductive systems The diversity of the result in reciprocal crosses between the same two species was long ago observed by Kolreuter To give an instance *Mirabilis jalapa* can easily be fertilised by the pollen of *M longiflora* and the hybrids thus produced are sufficiently fertile but Kolreuter tried more than two hundred times during eight following years to fertilise reciprocally *M longiflora* with the pollen of *M jalapa* and utterly failed Several other equally striking cases could be given Thuret has observed the same fact with certain sea weeds or *Fuci* Gartner moreover found that this difference of facility in making reciprocal crosses is extremely common in a lesser degree He has observed it even between closely related forms (as *Matthiola annua* and *g labra*) which many botanists rank only as varieties It is also a remarkable fact that hybrids raised from reciprocal crosses though of course compounded of the very same two species the one species having first been used as the father and then as the mother though they rarely differ in external character yet generally differ in fertility in a small and occasionally in a high degree

Several other singular rules could be given from Gartner for instance some species have a remarkable power of crossing with other species other species of the same genus have a remarkable power of impressing their likeness on their hybrid offspring but these two powers do not at all necessarily go together There are certain hybrids which instead of having as is usual

so th e of thei pure parent pec es, re th rare eptions e trem ly t l So again amon, t hybrid wl l re ll int me- diate truct re l tween tl pare ts, e ceptional l l rmal l l ls som tim s are born, l ul l el resembl of th r p re parent nd tl se l ybrid re al t al tterl t rule n wh tl e th r b l rids ra sed from seed from tl sa p ule } a co l rabl d gree of f t lity These facts sh w h w compl t l th f rt l ty f a hybrid m y be l pe l t of t t nal resemblance t tl p re p re t

Cons l ri g tl se ral rules w g en, l uli g rn tl f rt l ty f first uses and f h brids, w see th t when f rms, which must be consid red as good and distin t pec s, are ted th f rt l t grad tes from z ro to pe fect f rt lit t f rtil ty d r cer tai cond tio cess tl t tl ei f rtility be les be g m tl scept bl t fa

hybrids prod ced from tl is ross that the f rtil t of h brids t rel ted to tl d gree whicl th y resembl t mal ppearance eith parent and la tl tl t th facil ty f making first cros betwe any tw pec es not al med l tl vst mat af fi t d gree f resemblance t ach th Tl latt tat m t cl arly pro ed by th liff renc tl re lt f rec proeal crosse bet ee th sam tw peci s, f according

n. Th hybrids, m reci produced from reciprocal crosses ft d ff f rt l t

N w l tl ese compl and ingular rul heat that spec es h bee d ed w th t lt simply t pre t tl becoming con- f led nature I th k not F why sh ld the t rility be so trem l d ff re t m d gree be mous pec es re rossed, a l f wl ch m t ppose t ld be eq all mpo tant t keep from ble l g t g th Wl y sl ld the l gree of t ril t be innat ly ariabl tl l sduals of tl sam pecies Why should som pecies cross w tl facil t and t p luce ry t rile hybrid and th l vies cross w th trem difficult and y t t re luce fairly f rtil l ybrid Why should there oft be so great diff re ce in th result of reciprocal cross between th same two

peci Wh m y e n be asked has the prod t p bri ls, l diff rent d grees f t ility n t trictly elated to th f cil t of th first uni n between t n re t seem trange arrang m t.

nature, th t, in reciprocal crosses between th same tw peci s, the mal se al l m nt of m l

ces, and t p

th capacity f n pl t to be grafted or b dded n an th is un mportant f r th ir w lf re n tate f n ture I pres me that n ill suppose tl t this capacity is a *pecially* nd wed quality b t will admit th t t is incidental n diff re ce in th laws of growth f tl tw plants. W can som times see th reason why one tree will n t tak n an th from diff rence n th ir rate f growth, in the hardn ss of th wood n th period f th fl w r nature of th ir sap &c. b t multit d of cases we can ass gn n reaso wh t Great d rsity in th ize of two plants, o be g wood and th oth r

les and th th han l, losely allied pecies, nd an t f th sam pec s, can us all but n t in an bl be grafted w th ase B t this capa t as in hybrid sat n, l y o m ans absol t l g med b y t m tie affi ty Alth gh man listin t g nera w th n th sam fam l h bee grafted to- g tl in th case spec es f th sam g n w ll not take cl th Th pear an be grafted far m re read ly on tl q ince which is anked as a distin t g nus, than n th p- pl wh ch m mbe f th sam g nus. E n d ff rent ar tie f the pear tak w th d f f rent d gree f facility th q ce so do

different varieties of the apricot and peach on certain varieties of the plum

As Gartner found that there was sometimes an innate difference in different *individuals* of the same two species in crossing so Sageret believes this to be the case with different individuals of the same two species in being grafted together As in reciprocal crosses the facility of effecting an union is often very far from equal so it sometime

in difficulty on the gooseberry

We have seen that the sterility of hybrids which have their reproductive organs in an imperfect condition is a different case from pure species organs perfect cases run to a analogous occurs in grafting for Thouin found that three species of *Robinia* which seeded freely on their own roots and which could be grafted with no great difficulty on a fourth species when thus grafted were rendered barren On the other hand certain species of *Sorbus* when grafted on other species yielded twice as much fruit as when on their own roots We are reminded by this latter fact of the extraordinary cases of *Hippeastrum Passiflora* &c which seed much more freely when fertilised with the pollen of a distinct species than when fertilised with pollen from the same plant

We thus see that although there is a clear and great difference between the mere adhesion of grafted stocks and the union of the male and female elements in the act of reproduction yet that there is a rude degree of parallelism in the results of grafting and of crossing distinct species And as we must look at the curious and complex laws governing the facility with which trees can be grafted on each other as incidental on unknown differences in their vegetative systems so I believe that the still more complex laws governing the facility of first crosses are incidental on unknown differences in their reproductive systems These differences in both cases, follow to a certain extent as might have been expected systematic affinity by which term every kind of resemblance and dissimilarity between organic beings is attempted to be expressed The facts by no means seem to indicate that the greater or lesser difficulty of either grafting or crossing various species has been a special endowment although in the case of crossing the difficulty is as important for the endurance and stability of specific forms as in the case of grafting it is unimportant for their welfare

Origin and Causes of the Sterility of first Crosses and of Hybrids

At one time it appeared to me probable as it has to others that the sterility of first crosses and of hybrids might have been slowly acquired through the natural selection of slightly lessened degrees of fertility which, like any other variation spontaneously appeared in certain individuals of one variety when crossed with those of another variety For it would clearly be advantageous to two varieties or incipient species if they could be kept from blending on the same principle that, when man is selecting at the same time two varieties it is necessary that he should keep them separate In the first place it may be remarked that species inhabiting distinct regions are often sterile when crossed now it could clearly have been of no advantage to such separated species to have been rendered mutually sterile and consequently this could not have been effected through natural selection but it may perhaps be argued that if a species was rendered sterile with some one compatriot sterility with other species would follow as a necessary contingency In the second place it is almost as much opposed to the theory of natural selection as to that of special creation that in reciprocal crosses the male element of one form should have been rendered utterly impotent on a second form whilst at the same time the male element of this second form is enabled freely to fertilise the first form for this peculiar state of the reproductive system could hardly have been advantageous to either species

In considering the probability of natural selection having come into action in rendering species mutually sterile the greatest difficulty will be found to be in the existence of many graduated steps from slightly lessened fertility to absolute sterility It may be admitted that it would profit an incipient species if it were rendered in some slight degree sterile when crossed with its parent form or with some other variety for thus fewer bastardised and deteriorated offspring would be produced to commingle their blood with the new species in process of formation But he who will take the trouble to reflect on the steps by which this first degree of sterility could be increased

through nat ral select o to that h gh l gree hich is comm w th so many pecies, a d hich is m ersal w th spec s wh h l bee diff re tiated t a g ert o f m ly rank, will find th subject traord nar l compl Aft m t re reflect t seems to me that this co ld not h e bee ffected thro gh natural selection. Tak tl case f s two pecies hich he crossed produced f w and

h l l gree with m t al nf rti t ana l h thus pproached l y mall t p toward l sol t t ril t Y t an ad ance f this k nd if th theo y f natural select n be f l t he must l mcessa tl oc

sects na

tions tl tri t re d f rtil ty h bee lo ly accum lated b nat al selecti n, from an ad tag h ing bee tl d rectl g en t th commun t to hich th y be lo ged tl comm ties f th sam pecies b t an nd dual mal t bel g to soc l omi t f re d red l ghtly sterile h ro sed w tl so tl ar t ld not tl tself g an ad antag ndirectl g an ad antag to th th m d id l of tl sam anety th leading to the preser ti n.

B t t w ld be perfl us t discuss thi q estio l tail f w th pla ts w l co lu l e that th t rilit f ro sed y rs must be d to som pri pl quite ndepend t of t l select Both Gartn and K lr t h pro ed th t g ra in lud m rous pecies. series can be f med from peci wl ich wh crossed y ld few and f w seeds, t pecies wh l n produce single seed b t t ar affected by the polle of certai th pec es, f th g m w lls. It is l re man festl mpossibl to select th more t rile ind id ls, which h alread ceased to ld seed so tl t th acm of t rilit f tl g rm l ffected cannot ha bee gained thro gl select and from th law g rn g tl ario grad of terilit he g so f tl gh t the animal ai l g t l l k gd ns, m y inf that the use wh t t m be is th sam or nearly th same in all cases.

W w ll now k k l ttle lose t th probable nat re of tl d ff rences bet een speci

wh ch induce terility in first crosses and in h b ds. In the case of first rosses, the greater l d ffi lt n effect g an n and in bt.

se

be

reaching th ut as w

a pla t h a pistil too lo g fo the poll n t b s t acl the o arium It has also been bserved th t wh n the polle f pec e is placed th t gma f a d stantl all ed species, th gh th pollen tubes protrude, they do n t pen t t the t mat c face Again th mal l ment m y reach the fem l le m t but be i capable of causi g an embry to be de loped as seems to ha been the ase with some f Thu t expe ments on F ct. N planat can be gi n f these fact any m re than why certain tree can ot be grafted n others. Lastly an embryo m y b de l ped d th n pe i h t n arly period Th s i tt alt ti has n t bee ffici ntly tt ded t b t I b h e from b rvations communicated to m by M H tt, who has had gre t pen ce in hybrid g ph asants and fo ls, th t th rly d th f th mb y ry freq t cause of t rility in first crosses. Mr Salt has recently gi en th re

ty l these ggs had been maj rity f th f t lised ggs, the mbry had th r been pa t lly d l ped d h d th n

—

n t l ast t is k wn th t hybrids r sed from ry d tin t pec ar sometimes w ak and d arfed and perish t an ly g f which fact Max W ch a has rece tly g n som triking ase with hyb id will ws. It m be h re w rth t g th t in som cases f parth g esis, th mbry w th n tl g f ll m ths wh h had n t been f tilised pass thro gh th arly tage f de l pm t and th perish lik th mbryos prod ced by ross between d t ct pec es. Until becom g acquainted w th th se f ts, I was unw ll g to bel e e in tl freq nt early

death of hybrid embryos for hybrids when once born are generally healthy and long lived as we see in the case of the common mule Hybrids however ...

... generally placed under suitable conditions of life But a hybrid partakes of only half of the nature and constitution of its mother it may therefore before birth as long as it is nourished within its mother's womb or within the egg or seed produced by the mother be exposed to conditions in some degree unsuitable and consequently be liable to perish at an early period more especially as all very young beings are eminently sensitive to injurious or unnatural conditions of life But after all the cause more probably lies in some imperfection in the ...

... consequently exposed

In regard to the sterility of hybrids in which the sexual elements are ...

... that when animals and plants are removed from their natural conditions they are extremely liable to have their reproductive systems seriously affected This in fact is the great bar to the domestication of animals Between the sterility thus superinduced and that of hybrids there are many points of similarity In both cases the sterility is independent of general health and is often accompanied by excess of size or great luxuriance In both cases the sterility occurs in various degrees in both the male element is the most liable to be affected but sometimes the female more than the male In both the tendency goes to a certain extent with systematic affinity for whole groups of animals and plants are rendered impotent by the same unnatural conditions and whole groups of species tend to produce sterile hybrids On the other hand one spec... a ... of ... r ... y fertile hybrids No one can tell till he tries, whether any particular animal will breed under confinement, or any exotic plant seed freely under culture nor can he tell till he tries whether any two species of a genus will produce more or less sterile hybrids. Lastly when organic beings are placed during several generations under conditions not natural to them they are extremely liable to vary which seems to be partly due to their reproduct... systems ... in a ... So it ... essive ... rations are eminently liable to vary as every experimentalist has observed

Thus we see that when organic beings are placed under new and unnatural conditions, and when hybrids are produced by the unnatural crossing of two species the reproductive system independently of the general state of health is affected in a very similar manner In the one case the conditions of life have been disturbed though often in so slight a degree as to be inappreciable by us in the other case or that of hybrids the external conditions have remained the same but the organisation has been disturbed by two distinct structures and constitutions including of course the reproductive systems having been blended into one For it is scarcely possible that two organisations should be compounded into one without some disturbance occurring in the development, or periodical action or mutual relations of the different parts and organs one to another or to the conditions of life When hybrids are able to breed inter se they transmit to their offspring from generation to generation the same compounded organisation and hence we need not be surprised that their sterility though in some degree variable does not diminish it is even apt to increase this being generally the result, as before explained of too close interbreeding The above view of the sterility of hybrids being caused by two constitutions being compounded into one has been strongly maintained by Max Wichura.

It must however be owned that we cannot understand on the above or any other view several facts with respect to the sterility of hybrids for instance the unequal fertility of hybrids produced from reciprocal crosses or the increased sterility in those ...

... explanation is offered why an organism, when placed under unnatural conditions is rendered sterile All that I have attempted to show is that in two cases in some respects allied sterility is the common result —in the one case from the conditions of life having been disturbed in the other case from the organisation having been disturbed by two organisations being compounded into one

A similar parall lism hold good w th a allied y t ry diff rent class of facts. It is an ld and almost uni ersal b li f f unded a considerabl body f v der ce wl ch I h e

t bers, &c from e soil climate to an oth r and back again. D ring the con alesce ce of an mals, gre t benefit is d rived from lmost any chang in tl h b ts f life Again, both w th plants and animals, th re s the lear t id nce that cross bet een in t f l f th sam spec es wh ch diff to a

bee bjected t l gl tly d ff re t co l ti ns, l ch ha l gl tl aried gi gour and f rtl t t tl off p g B t, as w l seen, rgan be gs l g l al t ted to certain uni f rm cond t ns nd t t f t wl n bjected as d co fi m t, to consid able chang tl cond ti ns, y freq tly are rend red more less t ril and w kn w that cross betwee tw f rms, tl t h become ad ly pec fically diff re t, prod ce hybrid which are almost alw y in som d gree t rile I am f lly pers aded tl t thi d ble parall l sm by no m ans an acc d t or an ll sion. H wl is abl t plain why th lepl ant and multitud f th animals are nc pal l of breed g when k pt und nly part al conf. m t tl ir natu coun try ll be abl to plain th p mary cause of l b id being so g all t ril H w ll t the sam t in be l l t pl l w t s th t tl race of som of d t cated an mals, l l l ft bee bject d to w and not if m co id tio is, are q t f t l together alth gh tl are d scended from dist nct pec es, hich ld probably h been t ril f aborig nally rossed Th bo t parall l series of f ts seem to be connected togetl l y som co m b t known bond h h is ess tially rel ted t tl princ pl of lif this princi le accord g to Mr Herbert

Spencer being that life depends n or consists in the incessant action and react n of ar o s forces, wh ch as through ut n t e, are al w ys te ding t w rd an equilibr um and wh th tend ncy s slightly disturbed by any chang the v tal f rces gain in power

Reciprocal Dimorphism and Trimorphism

This subject may be here bri fly discussed a d will be found t throw some light on hy brid m Se r l pl ts bel ging to d tin t orders p esent tw f ms, whi h exist in ab t eq al numb rs and which diff r in no re pect e cept in th rep odu tive o gans e f rm

tam ns in th ize and col ur f the poll n g a s, n l in some tl r re pects and as n ach f th three f rms the are two sets f tam ns, th three f ms possess altog tl er six sets of tam ns an l th ee kinds of p st ls. Th o gans re so propo tioned in l gth t each th that l alf the stam ns in tw f the f m stand a l l with th t gma of th third f m N w I h hown d the re ult has been confi med by ther bserv s th t, i ord to obtain f ll f rt lity w th the e plants, t is necessary th t the st gma of th f rm sh uld be f rtil sed by poll n tak n from the t m ns f co r ponding l ght n anoth fo m So th t with dim rph speci s tw un ns, wh ch m y be called l git mat are f lly f rtile and two wh ch may be called ll git m t are m re less inf rt l W th tr m rphi peci six un ns l gitim t o f lly f rt l —and twel e are ill g timate, m re l ss inf rt l

Th inf rtil ty whi l m y be bserved n ari s d m rphi c and t m rphi pl ts wh n th y are ll g t m t ly f t l sed tl t s by poll tak from tamens n t cor espo d g in h ght w th th p til diff m h d gree up to absol te and tt t l ty j t in th sam mann as occur n ross g d s t ct peci s. As th d g ee f t lity n th l tte case d pe d in an emin t d gree n tl cond tions f lif b ing m re l ss f ur abl so I h f nd t w tl ll gitim te mo s. It is ll kn wn that if poll f d s t ct species be placed o th t gm of fl w er and its own polle be afte w rds, n afte a consid rable interval f tim placed n the

same stigma its action is so strongly prepotent that it generally annihilates the effect of the foreign pollen so it is with the pollen of the several forms of the same species for legitimate pollen is strongly prepotent over il legitimate pollen when both are placed on the same stigma I ascertained this by fertilising several flowers first illegitimately and twenty four hours afterwards legitimately with the pollen taken from a peculiarly coloured variety and all the seedlings were similarly coloured this shows that the legitimate pollen though applied twenty four hours subsequently had wholly destroyed or prevented the action of the previously applied illegitimate pollen Again as in making reciprocal crosses between the same two species there is occasionally a great difference in the result so the same thing occurs with trimorphic plants for instance the mid styled form of *Lythrum salicaria* was illegitimately fertilised with the greatest ease by pollen from the longer stamens of the short styled form and yielded many seeds but the latter form did not yield a single seed when fertilised by the longer stamens of the mid styled form

In all these respects and in others which might be added the forms of the same undoubted species when illegitimately united behave in exactly the same manner as do two distinct species when crossed This led me carefully to observe during four years many seedlings raised from several illegitimate unions The chief result is that these illegitimate plants as they may be called are not fully fertile It is possible to raise from dimorphic species both long styled and short styled illegitimate plants and from trimorphic plants all three illegitimate forms These can then be properly united in a legitimate manner When this is done there is no apparent reason why they should not yield as many seeds as did their parents when legitimately fertilised But such is not the case They are all infertile in various degrees some being so utterly and incurably sterile that they did not yield during four seasons a single seed or even seed-capsule The sterility of these illegitimate plants when united with each other in a legitimate manner may be strictly compared with that of hybrids when crossed *inter se* If on the other hand a hybrid is crossed with either pure parent species the sterility is usually much lessened and so it is when an illegitimate plant is fertilised by a legitimate plant In the same manner as the sterility of hybrids does not always run parallel with the difficulty of making the first cross between the two parent species, so the sterility of certain illegitimate plants was unusually great whilst the sterility of the union from which they were derived was by no means great With hybrids raised from the same seed capsule the degree of sterility is innately variable so it is in a marked manner with illegitimate plants Lastly many hybrids are profuse and persistent flowerers whilst other and more sterile hybrids produce few plants

Altogether there is the closest identity in character and behaviour between illegitimate plants and hybrids It is hardly an exaggeration to maintain that illegitimate plants are hybrids produced within the limits of the same species by the improper union of certain forms whilst ordinary hybrids are produced from an improper union between so-called distinct species We have also already seen that there is the closest similarity in all respects between first illegitimate unions and first crosses between distinct species This will perhaps be made more fully apparent by an illustration we may suppose that a botanist found two well marked varieties (and such occur) of the long styled form of the trimorphic *Lythrum salicaria* and that he determined to try by crossing whether they were specifically distinct He would find that they yielded only about one fifth of the proper number of seeds, and that they behaved in all the other above-specified respects as if they had been two distinct species But to make the case sure he would raise plants from his supposed hybridised seed and he would find that the seedlings were miserably dwarfed and utterly sterile and that they behaved in all other respects like ordinary hybrids He might then maintain that he had actually proved in accordance with the common view that his two varieties were as good and as distinct species as any in the world but he would be completely mistaken

The facts now given on dimorphic and trimorphic plants are important because they show us first that the physiological test of lessened fertility both in first crosses and in hybrids is no safe criterion of specific distinction secondly because we may conclude that there is some unknown bond which connects the infertility of illegitimate unions with that

of the r llcg t mat ff pring and we are led l t nd tl sa w to first cross d ı
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m y differ in no e pect wh tev r tt er in struct re r in const t t n relat ly to x ternal co d tions, and y t b te l wh n ted ce ta n ys. F w m t member that it is the f the se al l m nts f ind d ls f tl e same f rm f ı t ce f t lo g t led f rms, wl h lt tenl ty wl l t t s tl u f tl e sex al el re t t d t t f rms wh h s
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cı s. ıt ıs, really so b t I w ll t nl ge n th s obsc e l ject

We m y l f r as p b ble f m tl cons l tıo l d morph c and trım rphı plants, that th t rılıty f d st t pec h crossed and f th l b d p g y d pends l ly tl n t re f th se al lem nts, nd t a y d ff re ce ın th ır tru t re g al const t t n. W ar lso led to thıs sam co l by co d rı g eciprocal crosses, wh ch th m l f pecies an t be ted can be ted w th gre t d fficulty w tl tl f m l f a seco d spec s. l lst tl co rse ross can b ef fected w tl perfect facıl ty Th t cell t) sers Gä t l k se co l led tl t sp cie l en rossed re t l w g to l ffe nces co fi ed to tl r reprod tı sy t ms

F tıl ty f V a et es wl en C os ed a ıd of th M g el Off p ng not ı ı sal

It ma be rged as rwl lm g argu m t tl t tl re must b som sse tıal dıs t ct het ee pec l t s, as much as tl l tt l m l tl ma d ff fr m ac) tl t rı l ppe ce, tl pe fect facıl ty and y ld p rfectly f rt l ff ı rı g W tl som cept s, pres ently t be gı I f lly adm t that tl s ıs th rule B t tl bject rro nded by d ffi l tıes, f k k g to rı t prod ced und nature, ıf t f m h th rto rej ted to be arıetıes be f d any d gree tenl to gethe tl are t nce anked l m t na t lısts as specı s. For tance th blue and red ı mpern l, wh cl are co ıd red by m t botanists as arı tıes, are said by Gärtner to be q te st rıl wh n crossed and he ubse qu ntly ranks tl em as u doubted spec c If we tl u argue ın a c cl the fert lıty f ll v et c produced u d r natu e will ass redly h e t be g anted

If w turn to arıet produced o s p posed to ha e bee prod d unde d mest ı w are t ll n l ed ın some doubt

p ana prob l ly th true o that they are d sce ded f om bo g ally dıstı t pec s Ne tl el ss tl perfect f rt l ty of so m y d m t race d ff g w d ly from ach oth ı appe nce f r tance those f tl e p geon f tl e l b ge a remark bl fact m pec lly wh we reflect how m ny pec s there a wh cl tho gh sembl g ach otl r m t cl cly ar utte ly t ıl wh te d Se al cons derat s how rende tl e f rtıl tv f d me t c rı et es les emark ble In th first place t m y b bse ed tl t tl m nt of external dıf f re ce b t n tw pec ı u guıd to

ted pl t h be n s bjected h ve h d l ttl te d cy towards modıfy g th repro d t y t m ın man leadıng t mutual sterıl ty th t w ha good ground f ad m tt g tl d ectly ppo t doct n f Pallas am ly th t h c d t ns ge ally el mın te thı t nd y so tl t tl d me tıcated d sce d ts f pec wh h ın tl n tu al tate p b bly ld ha e been ın som d gree t l wl n c ssed becom perfectly f tıle t g th W tl plants, so f ltıv tı n from g ıng a tend y toward t rıl ty be twee dıstı ct pe s, tl t n se eral well tl t cated case lready ll ded to certa n

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reputed to be varieties, and which he tested by the severest trial, namely, by reciprocal crosses, and he found their mongrel offspring perfectly fertile. But one of these five varieties, when used either as the father or mother, and crossed with the *Nicotiana glutinosa*, always yielded hybrids not so sterile as those which were produced from the four other varieties when crossed with *N. glutinosa*. Hence the reproductive system of this one variety must have been in some manner and in some degree modified.

From these facts it can no longer be maintained that varieties when crossed are invariably quite fertile. From the great difficulty of ascertaining the infertility of varieties in a state of nature, for a supposed variety if proved to be infertile in any degree, would almost universally be ranked as a species;—from man attending only to external characters in his domestic varieties, and from such varieties not having been exposed for very long periods to uniform conditions of life;—from these several considerations we may conclude that fertility does not constitute a fundamental distinction between varieties and species when crossed. The general sterility of crossed species may safely be looked at, not as a special acquirement or endowment, but as incidental on changes of an unknown nature in their sexual elements.

Hybrids and Mongrels compared independently of their fertility

Independently of the question of fertility, the offspring of species and of varieties when crossed may be compared in several other respects. Gartner, whose strong wish it was to draw a distinct line between species and varieties, could find very few, and, as it seems to me, quite unimportant differences between the so-called hybrid offspring of species, and the so-called mongrel offspring of varieties. And, on the other hand, they agree most closely in many important respects.

I shall here discuss this subject with extreme brevity. The most important distinction is, that in the first generation mongrels are more variable than hybrids; but Gartner admits that hybrids from species which have long been cultivated are often variable in the first generation; and I have myself seen striking instances of this fact. Gartner further admits that hybrids between very closely allied species are more variable than those from very distinct species; and this shows that the difference in the degree of variability graduates away. When mongrels and the more fertile hybrids are propagated for several generations, an extreme amount of variability in the offspring in both cases is notorious; but some few instances of both hybrids and mongrels long retaining a uniform character could be given. The variability, however, in the successive generations of mongrels is, perhaps, greater than in hybrids.

This greater variability in mongrels than in hybrids does not seem at all surprising. For the parents of mongrels are varieties, and mostly domestic varieties (very few experiments having been tried on natural varieties), and this implies that there has been recent variability, which would often continue and would augment that arising from the act of crossing. The slight variability of hybrids in the first generation, in contrast with that in the succeeding generations, is a curious fact and deserves attention. For it bears on the view which I have taken of one of the causes of ordinary variability; namely, that the reproductive system from being eminently sensitive to changed conditions of life, fails under these circumstances to perform its proper function of producing offspring closely similar in all respects to the parent-form. Now hybrids in the first generation are descended from species (excluding those long-cultivated) which have not had their reproductive systems in any way affected, and they are not variable; but hybrids themselves have their reproductive systems seriously affected, and their descendants are highly variable.

But to return to our comparison of mongrels and hybrids: Gartner states that mongrels are more liable than hybrids to revert to either parent-form; but this, if it be true, is certainly only a difference in degree. Moreover, Gartner expressly states that hybrids from long cultivated plants are more subject to reversion than hybrids from species in their natural state; and this probably explains the singular difference in the results arrived at by different observers: thus Max Wichura doubts whether hybrids ever revert to their parent-forms, and he experimented on uncultivated species of willows; whilst Naudin, on the other hand, insists in the strongest terms on the almost universal tendency to reversion in hybrids, and he experimented chiefly on cultivated plants. Gartner further states that when any two species, although most closely allied to each other, are crossed with a third species, the hybrids

cases with species having a peculiar constitution sterility might occasionally be thus caused Thus as I believe we can understand why with domesticated animals varieties have not been produced which are mutually sterile and why with plants only a few such cases immediately to be given have been observed

The real difficulty in our present subject is not, as it appears to me why domestic varieties have not become mutually infertile when crossed but why this has so generally occurred with natural varieties as soon as they have been permanently modified in a sufficient degree to take rank as species We are far from precisely knowing the cause nor is this surprising seeing how profoundly ignorant we are in regard to the normal and abnormal action of the reproductive system But we can see that species owing to their struggle for existence with numerous competitors will have been exposed during long periods of time to more uniform conditions than have domestic varieties and this may well make a wide difference in the result. For we know how commonly wild animals and plants when taken from their natural conditions and subjected to captivity are rendered sterile and the reproductive functions of organic beings which have always lived under natural conditions would probably in like manner be eminently sensitive to the influence of an unnatural cross Domesticated productions on the other hand which as shown by the mere fact of their domestication were not originally highly sensitive to changes in their conditions of life and which can now generally resist with undiminished fertility repeated changes of conditions might be expected to produce varieties which would be little liable to have their reproductive powers injuriously affected by the act of crossing with other varieties which had originated in a like manner

I have not as yet spoken as if the varieties of the same species were invariably fertile when intercrossed But it is impossible to resist the evidence of the existence of a certain amount of sterility in the few following cases, which I will briefly abstract. The evidence is at least as good as that from which we believe in the sterility of a multitude of species The evidence is, also derived from hostile witnesses, who in all other cases consider fertility and sterility as safe criterions of specific distinction Gartner kept during several years a dwarf kind of maize with yellow seeds and a tall variety with red seeds growing near each other in his garden and although these plants have separated sexes they never naturally crossed He then fertilised thirteen flowers of the one kind with pollen of the other but only a single head produced any seed and this one head produced only five grains Manipulation in this case could not have been injurious, as the plants have separated sexes No one I believe has suspected that these varieties of maize are distinct species and it is important to notice that the hybrid plants thus raised were themselves *perfectly* fertile so that even Gartner did not venture to consider the two varieties as specifically distinct

Girou de Buzareingues crossed three varieties of gourd which like the maize has separated sexes and he asserts that their mutual fertilization is by so much the less easy as their differences are greater How far these experiments may be trusted I know not but the forms experimented on are ranked by Sageret, who mainly founds his classification by the test of infertility as varieties, and Naudin has come to the same conclusion

The following case is far more remarkable, and seems at first incredible but it is the result of an astonishing number of experiments made during many years on nine species of *Ver*

seed than the similarly coloured varieties of the same species Moreover he asserts that, when yellow and white varieties of one species are crossed with yellow and white varieties of a *distinct* species more seed is produced by the crosses between the similarly coloured flowers, than between those which are differently coloured Mr Scott also has experimented on the species and varieties of *Verbascum* and although unable to confirm Gartner s results on the crossing of the distinct species he finds that the dissimilarly coloured varieties of the same species yield fewer seeds in the proportion of 86 to 100 than the similarly coloured varieties Yet these varieties differ in no respect except in the colour of their flowers and one variety can sometimes be raised from the seed of another

Kolreuter whose accuracy has been confirmed by every subsequent observer has proved the remarkable fact that one particular variety of the common tobacco was more fertile than the other varieties when crossed with a widely distinct species He experimented on five forms which are commonly

reprod cti e s) t ms. Th re is no m re ason t think that specie h v bee spec ally n dowed tl an d gree f t rilty to p e- t th cross g nd bl d g in nature tl an t th k that tree l l een spec lly

ur f re ts.

Tl e t ril ty f first rosses and f th hy brid prog y has n t bee acq red tl ro gh tural select n. I th case f f rst crosse it seems to depe d se al re mstan es in som nstance l f p rt tl early d tl of the mbry I th case f hybr ds, it p- pare tly d pe d th h l ganisat l m bee dist bed by b g compo ded from t dist t form tl t ril ty b ing losel ll ed t tl t whi cl so freq tly f fect p re pec es, wl exposed to w and u nat ral cond t s f l f ll wh will plai tl se latt cases ll b bl t i l n tl t ril ty f l yb ds. Th is is stro gly pport d b parall lism f oth kind nam ly th t, firstly l gl t cl ang th ondi t ns f l f add to tl g d f rt l ty of all gan be gs and seco dly tl t tl cross f f s wl ich l b posed t sl ghtly d ff re t co l t f l f wl h h ar d f rs tl g and f tilt f tl e ff p g Tl facts g tl t ril ty f tl ll g t m t ns f d m rpl nd t ri l ic pla ts and f th ill g t m t l g i haj re d t probabl th t som kno bond all case o ects tl d gree of f tilt f first unions w th tl t f th ff r g. Tl cc l t f tl se fact di norph n, as ll as f th re lts f re ci rocal ro se l l l ad t tl co l that tl i ar ca se f tl t l ty f crossed pec co f ed t d ff ce in tl s l l ls. B t n tl ase f d t t pec es tl se al l ts wo ld so g all l been m in re l ss mod f ed lead t tl t al f rtil t w l t kr l t t see t ta j som k se re l t t pec es l g bee posed f l g

p r od of t m to nearly uniform cond t ns of life

It n t urp s g th t th diffi ulty in cro g any t o pecies, and th ter lity f

tween th pec s wh ch are cr sed N s t s rp g that the fac l ty f ffecting a fi t cross, d tl f rt lity f th hybrid thu pro- d ced and th cap c ty of bein grafted to- g th r tl o gh th l tt c pac ty e d tly d p d n d h d ff rent circ m tanc — hould all run t a rt n e t t, p all l w th the y t m t affin ty f the f rms b jected to xpe m t f y tem t c ffinity i l d s re mblance of all k ds.

F rst cros b twee fo m known t b vari t or fficiently l ke t b cons d ed as ri tie d the m ngrel ff p ng ery g ally b t n t, as so ften tated i ari bly fe til N is th alm t uni ersal and perfect fe t l ty urp ng when t m mbered h w l bl we re to argue n a rcle w th re pect to ariet s in state of t re and wh n rem mbe th t th gr ter n mb r of t l b n produced und r d me t cat n by th select n f mere e te nal d ff ren d th t th y h v not been l g posed t if m ond t n f lif It f ld lso b pec lly k pt in mind tl t l g-co t ed l m t t t d to l n n te terility and th f re l ttl lik ly t d ce th s sam qual ty Ind pendently f tl q t f f t l ty n ll oth respect th re is th l se t g al resembl ce between l y b d and m g ls — in tl variab l ty in th pow f abso bing each othe by re pe ted se d in tl inher tan f hara t from both p ent f rms. F n lly tl altl gl w re as g ant of the p cise ca se f th t l ty f first crosses and f hyb id as w re l y m ls and plant rem ed from th natur l co d ti s b com t ril t tl facts g en in this ch pt d t se t m pposed t th bel f th t pec bo g ally ted as a t es

whereas ... cies are ... with another species the hybrids do not differ much But this conclusion as far as I can make out, is founded on a single experiment and seems directly opposed to the results of several experiments made by Kolreuter

Such alone are the unimportant differences which Gartner is able to point out between hybrid and mongrel plants On the other hand the degrees and kinds of

... s follow according to Gartner the same laws When two species are crossed one has sometimes a prepotent power of impressing its likeness on the hybrid So I believe it to be with varieties of plants and with animal one variety certainly often has this prepotent power over anot ...

... mongrel plants from a reciprocal cross Both hybrids and mongrels can be reduced to either pure parent form by repeated crosses in successive generations with either parent.

These several remarks are apparently applicable to animals but the subject is here much complicated partly owing to the existence of secondary sexual characters but more especially owing to prepotency in transmitting likeness running more strongly in one sex than in the other both when one species is crossed with another and when one variety is crossed with another variety For instance I think those authors are right who maintain that the ass has a prepotent power over the horse so that both the mule and the hinny resemble more closely the ass than the horse but that the prepotency runs more strongly in the male than in the female ass, so that the mule which is the offspring of the male ... is ... is

... ress has been laid by some authors on the supposed fact that it is only with mongrels that the offspring are not intermediate in character but closely resemble one of their parents but this does sometimes occur with hybrids yet I grant much less frequently than with mongrels Looking to the cases which I have collected of cross-bred animals closely resembling one parent the resemblances seem chiefly confined to characters almost monstrous in their nature and which have suddenly appeared—such as albinism melanism deficiency of tail or horns, or additional fingers and toes and do not relate to characters which have been slowly acquired through selection A tendency to sudden reversions to the perfect character of either parent would also be much more likely to occur with mongrels which are descended from varieties often suddenly produced and semi-monstrous in character than with hybrids, which are descended from species slowly and naturally produced On the whole I entirely agree with Dr Prosper Lucas, who after arranging an enormous body of facts with respect to animals comes to the conclusion that the laws of resemblance of the child to its parents are the same whether the two parents differ little or much from each other namely in the union of individuals of the same variety or of different varieties or of distinct species.

Independently of the question of fertility and sterility in all other respects there seems to be a general and close similarity in the offspring of crossed species and of crossed varieties If we look at species as having been specially created and at varieties as having been produced by secondary laws, this similarity would be an astonishing fact. But it harmonises perfectly with the view that there is no essential distinction between species and varieties.

Summary of Chapter

First crosses between forms, sufficiently distinct to be ranked as species and their hybrids, are very generally but not universally sterile The sterility is of all degrees and is often so slight that the most careful experimentalists have arrived at diametrically opposite conclusions in ranking forms by this test. The sterility is innately variable in individuals of the same species and is eminently susceptible to the action of favourable and unfavourable conditions. The degree of sterility does not strictly follow systematic affinity but is governed by several curious and complex laws. It is generally different and sometimes widely different in reciprocal crosses between the same two species It is not always equal in degree in a first cross and in the hybrids produced from this cross

In the same manner as in grafting trees, the capacity in one species or variety to take on another is incidental on differences, generally of an unknown nature in their vegetative systems, so in crossing the greater or less facility of one species to unite with another is incidental on unknown differences in their

tend to support the ld and unimpro ed forms.

By the theory of natural selection all li in species ha been connected with the parent species of each genus, by differences not greater than w see between th natural and domestic arieties of the sam species t the present day and these parent species, now g nerally extinct, ha in their turn bee sim larly co nected th more ancient forms and so n backwards, alw con erging to the common ancestor of ach great lass. So that th number of intermediat and transitional link be t een al li ing and extinct species, mu t ha been inconcei ably great. B t assuredly if this theory be true, such ha li ed pon th earth.

On the Lapse f Time as i ferred from the rate of Deposition and extent of Denu dation

Independently of our not finding fossil re mains of such nfinitely num rous connecting links, t may be objected that time cannot have sufficed for so gre t an amount of organic change all chan es having been ffected slowly It is hardly possible for me to recall to the reader ho is not practical geologi t, the facts leading th mind feebl to comprehend the lapse of tim H ho can read r Charles Lyell grand work on the *Principle f Geology* which th f t re historian will recognise as having produced a revol tion in natural science and y t does not adm t how ast ha been the past periods of time may at once close this volume Not that t suffices to study th *Principles f Geology* or to read special treatises by different observers o separat formations, and to mark how ach thor t tempts to gi an inadequate idea of the dura tion of each formation, en of each stra tum. W can best gai some idea of past time by knowi g the agencies at work, and learning how deeply the surface of the land has been denuded, and how much sediment has been deposit d. As Ly ll has ll remarked the tent and thickness of our sedime tary formation are the result and the measure of the denuda tion hich the arth crust has se here un dergone Therefore man should xamine for himself the great piles of superimposed trata, and atch the ri lets bringi d n mud, and the es w ari g th sea-c ffs, in order to comprehend someth ng about the dur ation f pa t t me the monuments of which we all around us.

It is good t wand along the coast, when formed of mo rat ly hard rocks, and mark th process of degradation. The tides in mo t cases reach th cliff only for a sh rt tim twice a da and th wa es eat into th m only when th y are charged with sand or pebbles f r there is good idence that pure water ef fects nothing in wearing w y rock. At last the base of the cliff is undermined, h ge fragm nts fall d wn, and these remaining fixed ha to be w rn w om b tom, until afte being

of rocky cliff which is und rg in degradation we find that t is onl h re and th re alo g a sh rt l ngth o round promontory that the liff are at th present time suff ring. Th p pearance f th urface and th egetation show that lsewhere years ha elapsed since th wat rs washed their base.

W have, h w recently learnt from th observations of Ramsay in th van of many excellent obser rs—of J kes, G ikie Croll, and oth rs, that subaerial degradation is a much more important ag nc than coast ac tio th power of th wa es. Th wh le sur face of th land is xposed to th ch mical ac tion of th ai and of the rain w t r with its dissol ed carbolic acid, and n cold r coun tries to frost th disint gr ted matter car ried d wn n gentl lopes dur ng h eavy rain, and to a greater xtent than m ht be supposed, especiall in arid districts, by th wind t is then transported by th streams and ri ers, which when rapid deepen the chan nels, and trit rat th fragments On a rainy d n in a g tl undulat countr we see the ffects of subaerial d rad tion in th muddy rills which flow d wn ry lope Messrs. Ramsay and Wh take ha shown and the observati n is most triking o e, that th great lines of escarpm nt in th Weal den district and those ranging across England which f rmerly w re looked at as ncie t se coasts, cannot ha been th f rmed, for each h is composed of ne and th sam f rma tion, hilst ou sea-cliff are ry wh re f rmed

CHAPTER X

ON THE IMPERFECTION OF THE GEOLOGICAL RECORD

IN THE sixth chapter I enumerated the chief objections which might be justly urged against the views maintained in this volume Most of them have now been discussed One namely the distinctness of specific forms and their not being blended together by innumerable transitional links is a very obvious difficulty I assigned reasons why such links do not commonly occur at the present day under the circumstances apparently most favourable for their presence namely on an extensive and continuous area with graduated physical conditions I endeavoured to show that the life of each species depends in a more important manner on the presence of other already defined organic forms than on climate and therefore that the really governing conditions of life do not graduate away quite insensibly like heat or moisture I endeavoured also to show that intermediate varieties from existing in lesser numbers than the forms which they connect will generally be beaten out and exterminated during the course of further modification and improvement The main cause however of innumerable intermediate links not now occurring everywhere throughout nature depends on the very process of natural selection through which new varieties continually take the places of and supplant their parent forms But just in proportion as this process of extermination has acted on an enormous scale so must the number of intermediate varieties which have formerly existed be truly enormous Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain and this perhaps, is the most obvious and serious objection which can be urged against the theory The explanation lies as I believe in the extreme imperfection of the geological record

In the first place it should always be borne in mind what sort of intermediate forms must on the theory have formerly existed I have found it difficult when looking at any two species to avoid picturing to myself forms *directly* intermediate between them But this is a wholly false view we should always look for forms intermediate between each species and a common but unknown progenitor and the progenitor will generally have differed in some respects from all its modified descendants To give a simple illustration the fantail and pouter pigeons are both descended from the rock pigeon if we possessed all the intermediate varieties which have ever existed we should

tail and pouter none for instance combining a tail somewhat expanded with a crop somewhat enlarged the characteristic features of these two breeds These two breeds moreover

have determined from a mere comparison of their structure with that of the rock pigeon, *C livia* whether they had descended from this species or from some allied form such as *C nas*

So with natural species if we look to forms very distinct, for instance to the horse and tapir we have no reason to suppose that links directly intermediate between them ever existed but between each and an unknown common parent The common parent will have had in its whole organisation much general resemblance to the tapir and to the horse but in some points of structure may have differed considerably from both even perhaps more than they differ from each other Hence in all such cases we should be unable to recognise the parent form of any two or more species, even if we closely compared the structure of the p ants perfec

It is just possible by the theory that one of two living forms might have descended from the other for instance a horse from a tapir and in this case direct intermediate links will have existed between them But such a case would imply that one form had remained for a very long period unaltered whilst its descendants had undergone a vast amount of change and the principle of competition between organism and organism between child and parent will render this a very rare event for in all cases the new and improved forms of life

years. But let t be borne in mind, in relation to the subject of this work, what hundred years imples, represented as t is b a measure ut terly insignificant in a hall of the above dimensions. Several eminent breeders, during sin gle Lifetime, have so largely modified some of the higher animals which propagat their kind much more sowl than most of the low ani mals, that the ha formed what w ll deserves to be caled new sub-breed. F w m n ha attended with due care to an one strain for more than had century so that a hundred ears represents the work of two breed rs in succession. It is not to be supposed that species in a stat of nature er change so quickl as domestic animals under the guidance of methodical selection. The comparison would be in every w fairer with th ffects which f llow from unconscious selection, that is the prese ation of the most *useful or beautiful animals*, th no intention of modifying the breed but b this process of unconscious selection, various breeds ha been sensibl changed in the course of two or three centuries.

pecies how ve probabl chang much more slowl and withi the sam country nly *few change at the same time* This slowness follow from al the inhab tants of the sam country being alread so w ll adapted to each other that new places in the polit of nature do not occur until afte long int rvals, du to the occurrence of ph ical changes of som kind, or through the immigration of new forms. Moreo er ariations or individual differences of the right nature b which som of the inhabitants might be better fitted to their new places under the altered circumstances, would not alw occur t nce Unfortunatel w ha no means of determining, according to the standard of ears, how long a period t takes to modif pecies b t to the subject of tim m st return.

O the Poorness f Pa eontological Collect ns

N w let us t rn to ou richest geological museum and what paltry di pla w behold That our collection are im erfect is ad mitted b every one The remark of that admirable palaeontologist, Ed ard Forbes, should not be forgotten, namel that ery many f ssil were are kno n and nam d from single and *often* broken specim ns, or from few sp cime collected on some one spot. Only small p rt on f the surface of the earth has been geologicall plored, and no part w th sufficient care as th important disco eries mad every year in Europe prove. No organ ism wholl soft can be preserved. Shells and bones decay and disappear when left *on the bottom* of the sea, wh re sediment is not accu mulating. W probably take a quite rro eou view when w assume that sediment is bein *d posited r nearly th whole* bed of th sea, at a rate sufficiently quick to embed and pre serve fossil remains. Throughout an n mously large proportion of th ocean, th bright bl tint of th w ter bespeaks ts p ty Th many cases n record of a formation conformably cov red, after an immense int val of time, b anoth r and late formation, witho t th und rlying bed having suff red in the interval any wear and tear seem xplicable only n the ew of the bott m of the sea not rarel ing f ages in an unaltered cond tion. Th remains which d becom embedded if in sand o gra el, will, when the beds re upraised, generally be dissol ed by th percolation of rain-w te charged with carbolic acid Som of th many kinds of animals which live n the beach between high and low w t mark seem to be rarely preserved F r instance the several species of the Chthamalinae (sub-famil of sessile cirripedes) coat th rocks all v th world in infinite numbers th are all strictly littoral, with the except n of a single Mediterranean species, which inhab t deep water and this has been found fossil in Sicil whereas not one other species has h th rto been f und in any tertiary forma tion v t t is known that the genus Chthamalus exi ted during the Chalk period. Lastly many gre t d posits requiring a ast length of tim f their accumulation, are entirely destitut of organi remains, witho t our being able to assign an reason one of th most triking in tances is that of the Fl sch f rmation, which consi ts of shale and sands on se eral thousand, occasional even six thousand feet in thickness, and extending f at lea t 300 miles from V enna to Switzerland and although this great mass has been most carefully searched, no fossils, except a few egetable remains, ha been found.

W th respect to the t rrestrial prod ctions which lived during th Secondary and Palaeozoic periods, t is perfluous to state that our evidence is fragmentary in an extreme degree For instance until recentl not a land sh ll was know belonging to either of these ast periods, w th the xception of one species dis co ered b ir C L ll and D D wson in th

to the rocks of which they are composed having resisted subaerial denudation better than the surrounding surface this surface consequently has been gradually lowered with the lines of harder rock left projecting Nothing impresses the mind with the vast duration of time according to our ideas of time more forcibly than the conviction th [illegible] t

[illegible]

[illegible] u great results

When thus impressed with the slow rate at which the land is worn away through subaerial and littoral action it is good in order to appreciate the past duration of time to consider on the one hand the masses of rock which have been removed over many extensive areas and on the other hand the thickness of our sedimentary formations I remember having been much struck when viewing volcanic islands which have been worn by the waves and pared all round into perpendicular cliffs of one or two thousand feet in height for the gentle slope of the lava streams due to their formerly liquid state showed at a glance how far the hard rocky beds had once extended into the open ocean The same story is told still more plainly by faults—those great cracks along which the strata have been upheaved on one side or thrown down on the other to the height or depth of thousands of feet for since the crust cracked and it makes no great difference whether the upheaval was sudden or as most geologists now believe was slow and effected by many starts the surface of the land [illegible] that no [illegible] externally [illegible] nce ex [illegible] ong this [illegible] strata varies from 600 to 3000 feet Professor Ramsay has published an account of a downthrow in Anglesea of 2300 feet and he informs me that he fully believes that there is one in Merionethshire of 1 000 feet yet in these cases there is nothing on the surface of the land to show such prodigious movements the pile of rocks on either side of the crack having been smoothly swept away

On the other hand in all parts of the world the piles of sedimentary strata are of wonderful thickness In the Cordillera I estimated one mass of conglomerate at ten thousand feet and although conglomerates have probably been accumulated at a quicker rate than finer sediments yet from being formed of worn and rounded pebbles, each of which bears the stamp of time they are good to show how slowly the mass must have been heaped together Professor Ramsay has given me the maximum thickness, from actual measurement in most cases, of the successive formations in *different* parts of Great Britain and this is the result —

	Feet
Palæozoic strata (not including igneous beds)	5 154
Secondary strata	13,190
Tertiary strata	2, 40

—making altogether 72 584 feet that is, very nearly thirteen and three quarters British miles Some of the formations which are represented in England by thin beds are thousands of feet in thickness on the Continent Moreover between each successive formation we have in the opinion of most geologists, blank periods of enormous length So that the lofty pile of sedimentary rocks in Britain gives but an inadequate idea of the time which has elapsed during their accumulation The consideration of these various facts impresses the mind almost in the same manner as does the vain endeavour to grapple with the idea of eternity

Nevertheless this impression is partly false Mr Croll in an interesting paper remarks that we do not err in forming too great a conception of the length of geological periods, but in estimating them by years. When geologists look at large and complicated phenomena, and then at the figures representing several million years the two produce a totally different effect on the mind and the figures are at once pronounced too small In regard to subaerial denudation Mr Croll shows, by calculating the known amount of sediment annually brought down by certain rivers, relatively to their areas of drainage that 1000 feet of solid rock as it became gradually disintegrated would thus be removed from the mean level of the whole area in the course of six million years This seems an astonishing result and some considerations lead to the suspicion that it may be too large but even if halved or quartered it is still very surprising Few of us, however know what a million really means Mr Croll gives the following illustration take a narrow strip of paper 83 feet 4 inches in length and stretch it along the wall of a large hall then mark off at one end the tenth of an inch This tenth of an inch will represent one hundred years, and the entire strip a million

years. But let it be borne in mind, in relation to the subject of this work, what a hundred years implies, represented as it is by a measure of time utterly insignificant in a hall of the above dimensions. Several eminent breeders, during a single lifetime, have so largely modified some of the higher animals which propagate their kind much more slowly than most of the lower animals, that they have formed what well deserves to be called a new sub-breed. Few men have attended with due care to any one strain for more than half a century, so that a hundred years represents the work of two breeders in succession. It is not to be supposed that species in a state of nature ever change so quickly as domestic animals under the guidance of methodical selection. The comparison would be in every way fairer with the effects which follow from unconscious selection, that is the preservation of the most useful or beautiful animals, with no intention of modifying the breed; but by this process of unconscious selection, various breeds have been sensibly changed in the course of two or three centuries.

Species, however, probably change much more slowly, and within the same country only a few change at the same time. This slowness follows from all the inhabitants of the same country being already so well adapted to each other, that new places in the polity of nature do not occur until after long intervals, due to the occurrence of physical changes of some kind, or through the immigration of new forms. Moreover, variations or individual differences of the right nature, by which some of the inhabitants might be better fitted to their new places under the altered circumstances, would not always occur at once. Unfortunately we have no means of determining, according to the standard of years, how long a period it takes to modify a species; but to the subject of time we must return.

On the Poorness of Palæontological Collections

Now let us turn to our richest geological museums, and what a paltry display we behold! That our collections are imperfect is admitted by every one. The remark of that admirable palæontologist, Edward Forbes, should never be forgotten, namely, that very many fossil species are known and named from single and often broken specimens, or from a few specimens collected on some one spot. Only a small portion of the surface of the earth has been geologically explored, and no part with sufficient care, as the important discoveries made every year in Europe prove. No organism wholly soft can be preserved. Shells and bones decay and disappear when left on the bottom of the sea, where sediment is not accumulating. We probably take a quite erroneous view, when we assume that sediment is being deposited over nearly the whole bed of the sea, at a rate sufficiently quick to embed and preserve fossil remains. Throughout an enormously large proportion of the ocean, the bright blue tint of the water bespeaks its purity. The many cases on record of a formation conformably covered, after an immense interval of time, by another and later formation, without the underlying bed having suffered in the interval any wear and tear, seem explicable only on the view of the bottom of the sea not rarely lying for ages in an unaltered condition. The remains which do become embedded, if in sand or gravel, will, when the beds are upraised, generally be dissolved by the percolation of rain-water charged with carbonic acid. Some of the many kinds of animals which live on the beach between high and low water mark seem to be rarely preserved. For instance, the several species of the Chthamalinæ (a sub-family of sessile cirripedes) coat the rocks all over the world in infinite numbers: they are all strictly littoral, with the exception of a single Mediterranean species, which inhabits deep water, and this has been found fossil in Sicily, whereas not one other species has hitherto been found in any tertiary formation: yet it is known that the genus Chthamalus existed during the Chalk period. Lastly, many great deposits requiring a vast length of time for their accumulation, are entirely destitute of organic remains, without our being able to assign any reason: one of the most striking instances is that of the Flysch formation, which consists of shale and sandstone, several thousand, occasionally even six thousand feet in thickness, and extending for at least 300 miles from Vienna to Switzerland; and although this great mass has been most carefully searched, no fossils, except a few vegetable remains, have been found.

With respect to the terrestrial productions which lived during the Secondary and Palæozoic periods, it is superfluous to state that our evidence is fragmentary in an extreme degree. For instance, until recently not a land shell was known belonging to either of these vast periods, with the exception of one species discovered by Sir C. Lyell and Dr. Dawson in the

to the rocks of which they are composed having resisted subaerial denudation better than the surrounding surface this surface consequently has been gradually lowered with the line of harder rock left projecting [illegible]

[illegible] than the conviction thus gained that subaerial agencies which apparently have so little power and which seem to work so slowly have produced great results

When thus impressed with the slow rate at which the land is worn away through subaerial and littoral action it is good in order to appreciate the past duration of time to consider on the one hand the masses of rock which have been removed over many extensive areas and on the other hand the thickness of our sedimentary formations I remember having been much struck when viewing volcanic islands which have been worn by the waves and pared all round into perpendicular cliffs of one or two thousand feet in height for the gentle slope of the lava streams, due to their formerly liquid state showed at a glance how far the hard rocky beds had once extended into the open ocean The same story is told still more plainly by faults —those great cracks along which the strata have been upheaved on one side or thrown down on the other to the height or depth of thousands of feet for since the crust cracked and it makes no great difference whether the upheaval was sudden or as most geologists now believe was slow and effected by many starts the surface of the land has been so completely planed down that no trace of these vast dislocations is externally [illegible]

[illegible] varies from 600 to 3000 feet Professor Ramsay has published an account of a downthrow in Anglesea of 2300 feet and he informs me that he fully believes that there is one in Merionethshire of 12,000 feet yet in these cases there is nothing on the surface of the land to show such prodigious movements the pile of rocks on either side of the crack having been smoothly swept away

On the other hand in all parts of the world the piles of sedimentary strata are of wonderful thickness In the Cordillera I estimated one mass of conglomerate at ten thousand feet and although conglomerates have probably been accumulated at a quicker rate than finer sediments yet from being formed of worn and rounded pebbles each of which bears the stamp of time they are good to show how slowly the mass must have been heaped together Professor Ramsay has given me the maximum thickness, from actual measurement in most cases of the successive formations in *different* parts of Great Britain and this is the result —

	Feet
Palaeozoic strata (not including igneous beds)	57,154
Secondary strata	13,190
Tertiary strata	2,240

—making altogether 72,584 feet that is, very nearly thirteen and three quarters British miles Some of the formations which are represented in England by thin beds are thousands of feet in thickness on the Continent Moreover between each successive formation we have in the opinion of most geologists, blank periods of enormous length So that the lofty pile of sedimentary rocks in Britain gives but an inadequate idea of the time which has elapsed during their accumulation The consideration of these various facts impresses the mind almost in the same manner as does the vain endeavour to grapple with the idea of eternity

Nevertheless this impression is partly false Mr Croll in an interesting paper remarks that we do not err in forming too great a conception of the length of geological periods, but in estimating them by years. When geologists look at large and complicated phenomena and then at the figures representing several million years the two produce a totally different effect on the mind and the figures are at once pronounced too small In regard to subaerial denudation Mr Croll shows, by calculating the known amount of sediment annually brought down by certain rivers, relatively to their areas of drainage that 1000 feet of solid rock as it became gradually disintegrated would thus be removed from the mean level of the whole area in the course of six million years This seems an astonishing result, and some considerations lead to the suspicion that it may be too large but even if halved or quartered it is still very surprising Few of us, however know what a million really means Mr Croll gives the following illustration take a narrow strip of paper 83 feet 4 inches in length and stretch it along the wall of a large hall then mark off at one end the tenth of an inch This tenth of an inch will represent one hundred years and the entire strip a million

sured, b t which will hardly last to distant geological age was deposited d ring down ard oscilation of lev l, and thus gained con- si icl es

[illegible]

sidence b t nl here th sup [illegible] as suffice t t keep the sea shallow and to mord and preserv the remains before the had time t deca On th e oth hand, as long as the bed of the se remains tationary *thick* deposits annot ha been accum lated the shallow parts, which are the most f ourabl to lf St ll le can this ha happened during the alternat periods of le tion t speak more accurat l tl bed which w re th n e cumulated w ll generall ha been destro ed by being raised and t ro ght w thi the lim ts of the coast act on.

These remarks ppl ei fly t l lt ral l sub-littoral deposits. In th case of an ten si and shallow sea, uch as that w thin a lar part of the Malay Archipelago, wh re th depth aries from 30 40 t 60 f th ms, a w ly t led f rmation might be f rmed during period of l tion, nd t not suffer

[illegible]

eh t was formed ne would tl d posit be much co ol lated no be capped b rlying formations, so that t w uld run good hance of being worn b tmos ric degrada- t on and b the action of the se luring ubse- quent o llatio of le l. It has, how been sugges ed l M H pkins, that if o part of tl a alt rising and before be g sen ed ed, the deposit formed d the rising mo ement th ugh not thick, might aft rwards become protected by fresh accum lat ons and thus be pr rv d for lon period.

M H pk [illegible] ses his belief that sedim tar bed f onsiderable horizontal exte t l ar l bee omp t ly destroyed. B t al w ha s [illegible] ting the f w ho be- lie t at ou present metamorphic schists and p tonic roc once f rmed th primordial [illegible] d admit that these latt rocks ha been str t d of their co ering to an enormous t nt For t is scar ly possible that such rocks could ha e been solidified and crystallized whil t uncovered b t if th m ta- m rphic action occurred t profound depths of th ocean, the forme protecting mantle f rock may n t ha been ery thi k. Admittin th n that gn iss, mica schist granit d orite, [illegible] necessarily co red up, I w can

[illegible]

[illegible]

bee compl t l d uded of all f ing trata That ca tens e areas do exist nnot be d l ted th granitic region of Parim is d scribed by Humboldt as being as leat ni teen t mes as large as S tz land So th of the Amazon, Bo col urs an area composed of rocks of this nature as equal to that f Spain, France, Ital part of German and th Brit ish Islands, ll co j ed. This reg has n t *been caref lly explored*, b t *from th co* cu re t testim y of tra llers, the granit rea is ry large thus, n Eschweg gi es a de- tailed section of these rocks, tret hin from Rio d Janeiro f 60 geogr p cal m les in land m traight lin and I tra lled for 1 0 miles n anothe d rect on, an l saw n thing b t granitic rocks. Num rous pecim ns, col- lect d along th wh le coast *from n ar R io* Janeiro t the m th of th l lata, a distance of 1100 geographical miles, were xamined by m and the all belo ed t this las. Inland alo th whole north rn bank of the Plata I saw besides modern t rtiary beds, only one *mall* patch *f slightl* m tamorp' osed rock, which alo could l f rmed a part of the original capping of the granitic series. Turn ng to w ll kn wn region, namel to th United States and Canada, as shown in Prof sso H D Rogers bea tiful map, I ha estimated the areas b cuttin o t and w ghin th pape and I fi d that the m tamorphic (ex cl ding th sem m tam rphic) and granitic rocks eed, in tl *proportion of 19 to 1* t hole of the n wer Palaeozo f rmati ns. I many regions th m tam rphic and granitic rocks would be found mucl m re wid ly t nd d than they ppear to be if all th sedi- m tary beds w re remo ed which rest unc n- *f rmabl* on them and wh ch could n t ha formed part of th riginal mantle und which th y w re crystallized Hence t is probable that in som parts of th w rld whole *f rm* tions ha been completely den ded with not a wreck left behind.

One remark is here w rth passing notice. During periods f le tion th area of the

carboniferous strata of North America but now land shells have been found in the lias In regard to mammiferous remains a glance at the historical table published in Lyell's *Manual* will bring home the truth how accidental and rare is their preservation far better than pages of detail Nor is their rarity surprising when we remember how large a proportion of the bones of tertiary mammals have been discovered either in caves or in lacustrine deposits and that not a cave or true lacustrine bed is known belonging to the age of our secondary or palæozoic formation

But the imperfection in the geological record largely results from another and more important cause than any of the foregoing namely from the several formations being separated from each other by wide intervals of time This doctrine has been emphatically admitted by many geologists and palæontologists who like E Forbes entirely disbelieve in the change of species When we see the formations tabulated in written works or when we follow them in nature it is difficult to avoid believing that they are closely consecutive But we know for instance from Sir R Murchison's great work on Russia what wide gaps there are in that country between the superimposed formations so it is in North America and in many other parts of the world The most skilful geologist if his attention had been confined exclusively to these large territories would never have suspected that during the periods which were blank and barren in his own country great piles of sediment, charged with new and peculiar forms of life had elsewhere been accumulated And if in each separate territory hardly any idea can be formed of the length of time which has elapsed between the consecutive formations we may infer that this could nowhere be ascertained The frequent and great changes in the mineralogical composition of consecutive formation generally implying great changes in the geography of the surrounding lands, whence the sediment was derived accord with the belief of vast intervals of time having elapsed between each formation

We can I think see why the geological formations of each region are almost invariably intermittent that is, have not followed each other in close sequence Scarcely any fact struck me more when examining many hundred miles of the South American coasts, which have been upraised several hundred feet within the recent period than the absence of any recent deposits sufficiently extensive to last for even a short geological period Along the whole west coast which is inhabited by a peculiar marine fauna tertiary beds are so poorly developed that no record of several successive and peculiar marine faunas will probably be preserved to a distant age A little reflection will explain why along the rising coast of the western side of South America no extensive formations with recent or tertiary remains can anywhere be found though the supply of sediment must for ages have been great, from the enormous degradation of the coast rocks and from muddy streams entering the sea. The explanation no doubt is that the littoral and sub littoral deposits are continually worn away as soon as they are brought up by the slow and gradual rising of the land within the grinding

or extensive masses in order to withstand the incessant action of the waves when first upraised and during successive oscillations of level as well as the subsequent subaerial degradation Such thick and extensive accumulations of sediment may be formed in two ways either in profound depths of the sea, in which case the bottom will not be inhabited by so many and such varied forms of life as the more shallow seas and the mass when upraised will give an imperfect record of the organisms which existed in the neighbourhood during the period of its accumulation Or sediment may be deposited to any thickness and extent over a shallow bottom if it continue slowly to subside In this latter case as long as the rate of subsidence and the supply of sediment nearly balance each other the sea will remain shallow and favourable for many and varied forms and thus a rich fossiliferous formation thick enough when upraised to resist a large amount of denudation may be formed

I am convinced that nearly all our ancient

watched the progress of geology and have been surprised to note how author after author in treating of this or that great formation has come to the conclusion that it was accumulated during subsidence I may add that the only ancient tertiary formation on the west coast of South America which has been bulky enough to resist such degradation as it has yet

of th glacial period, instead of h ing been really far greater that is, tend g from before the glacial epoch t th present day

In ord to g t perfect grad ti n between two forms in the uppe and low parts of th same form tion, the d po t must ha g n on co tin ously accum lating d rin long period fficient f th sl w process f mod ...

approximat ly the same which necessary that the sam mari pecies may li n th same space, the supply of sedim t must nearly count rbalance th am unt f bsidence. B t this same m ment of subsid nce ill tend to bm rg th area wh ce the sediment is deri ed and th diminish the ppl whil t th d ward m m nt co tin es. I fact, this arl xact balancing bet een the ppl f sedim t and the am unt of bsidence is probably rare co t g ncy for t has been observed by m re than ne palaeontologist, that ry thick d posits are usually barre of rganic remains, except n ar their ppe low lim ts.

It ould seem that ach separat f rmation, lik the hole p le of f rm t ns in any country has gen ally bee int rm ttent in ts accum lation. When w see as is so oft th ase f rmation composed of bed of wid ly diff re t m ak gical composition, w may reasonabl u pect that th process of d position has been more les terrupted. N ill the closest pection of f rmatio gi e us an id of th le gth of tim which ts d position may ha cons med Man stances could be gi of beds only few feet in thickness, represe t f rmati s, which are lsewhere thousar l of feet thickness, and hich must ha required an normo p riod for thei accumulation t no norant of this fact would ha en u pected the ast lapse of t m represe t d b th thinner formation. Man cases could be gi of the lower b d of format m ha ng bee praised, denuded nd merged, and th en re-covered b the ppe be l of the same formation, —facts, sh hat l t asily looked ter als ha occurred ts accum lat n I othe ases w ha the plainest vidence in gre t fossilised trees, til standin upright as th y grew of ma y l g int rvals of time and chang f l l during the process of deposition, which w ld n t ha been suspected had t th trees been preserved thus S C L y ll and Dr D wson found carboniferous beds 1400 feet thick in No a Scot a, w th ancient root-bearin strata, on abo e tl tl r t less than ixty-ei ht diff rent l

...

sam spot d rin th e wh le period f depos t n, b t has disappeared and reappeared per hap many times, durin the sam geol gical period Consequ tly if it were to undergo a consid rabl am unt f modification during th d positi n of any ne geol gical f rmat on a sectio would n t includ all th fin int r mediate gradat ns which must on ur theory ha xisted, b t abrupt, th gh perh p

...

f re ce between any two f ms, th y rank both as peci s, unless th y are nabled to connect th m t tl by th closest int rmediate grad t ns and this, from the reasons j t assigned, w can seld m h pe t ffect in any

...

tri tly int med t between B and C t w ld simply be ranked as third and distin t speci s, nl ss t tl sam tim t could be cl sely connected by int mediate a t es w th th both f rms. N ho ld t be f gotten, as bef re explained th t A might be tl act al prog t of B and C and t w ld not ecessarily be tri tly int r mediat between th m in all respects. So th t w m ght obtai tl parent species, and t se ral modified d scendants from th l w and ppe beds of th sam f rmation, and less w obtained m rous transit al gradations, w sh ld not recognise th ir blood relationsh p and should conseq tly rank th m as distin t spec es.

It is notorious on what xcessi ly l ht differences many palaeo t lo ts ha e f unded their pecie and th d this th m re read ly if th pecim ns om from diff rent ubtages of the sam formation. Som xperienced concholo st are w sinking many f

land and of the adjoining shoal parts of the sea will be increased, and new stations will often be formed;—all circumstances favourable, as previously explained, for the formation of new varieties and species; but during such periods there will generally be a blank in the geological record. On the other hand, during subsidence, the inhabited area and number of inhabitants will decrease (excepting on the shores of a continent when first broken up into an archipelago), and consequently during subsidence, though there will be much extinction, few new varieties or species will be formed; and it is during these very periods of subsidence, that the deposits which are richest in fossils have been accumulated.

On the Absence of Numerous Intermediate Varieties in any Single Formation.

From these several considerations, it cannot be doubted that the geological record, viewed as a whole, is extremely imperfect; but if we confine our attention to any one formation, it becomes much more difficult to understand why we do not therein find closely graduated varieties between the allied species which lived at its commencement and at its close. Several cases are on record of the same species presenting varieties in the upper and lower parts of the same formation; thus, Trautschold gives a number of instances with ammonites; and Hilgendorf has described a most curious case of ten graduated forms of *Planorbis multiformis* in the successive beds of a fresh-water formation in Switzerland. Although each formation has indisputably required a vast number of years for its deposition, several reasons can be given why each should not commonly include a graduated series of links between the species which lived at its commencement and close; but I cannot assign due proportional weight to the following considerations.

Although each formation may mark a very long lapse of years, each probably is short compared with the period requisite to change one species into another. I am aware that two palæontologists, whose opinions are worthy of much deference, namely Bronn and Woodward, have concluded that the average duration of each formation is twice or thrice as long as the average duration of specific forms. But insuperable difficulties, as it seems to me, prevent us from coming to any just conclusion on this head. When we see a species first appearing in the middle of any formation, it would be rash in the extreme to infer that it had not elsewhere previously existed. So again when we find a species disappearing before the last layers have been deposited, it would be equally rash to suppose that it then became extinct. We forget how small the area of Europe is compared with the rest of the world; nor have the several stages of the same formation throughout Europe been correlated with perfect accuracy.

We may safely infer that with marine animals of all kinds there has been a large amount of migration due to climatal and other changes; and when we see a species first appearing in any formation, the probability is that it only then first immigrated into that area. It is well known, for instance, that several species appear somewhat earlier in the palæozoic beds of North America than in those of Europe; time having apparently been required for their migration from the American to the European seas. In examining the latest deposits in various quarters of the world, it has everywhere been noted, that some few still existing species are common in the deposit, but have become extinct in the immediately surrounding sea; or, conversely, that some are now abundant in the neighbouring sea, but are rare or absent in this particular deposit. It is an excellent lesson to reflect on the ascertained amount of migration of the inhabitants of Europe during the

of climate, and on the great lapse of time, all included within this same glacial period. Yet it may be doubted whether, in any quarter of the world, sedimentary deposits, *including fossil remains*, have gone on accumulating within the same area during the whole of this period. It is not, for instance, probable that sediment was deposited during the whole of the glacial period near the mouth of the Mississippi, within that limit of depth at which marine animals can best flourish: for we know that great geographical changes occurred in other parts of America during this space of time. When such beds as were deposited in shallow water near the mouth of the Mississippi during some part of the glacial period shall have been upraised, organic remains will probably first appear and disappear at different levels, owing to the migrations of species and to geographical changes. And in the distant future, a geologist, examining these beds, would be tempted to conclude that the average duration of life of the embedded fossils had been less than that

tion of the geological record und r an mag mary illustration. The Malay Arch pelag is about the size of Europe from th N rth C pe to the Med terranean, and from Britain to Russia and th ref re eq als all the geol gical *formations* wh ch ha bee xam ed with any accu acy cepting those of the U ted tates of Am rica. I fully agree w th M God win Aust n, that the prese t co d tio f the Malay Arch pelago with ts m rous large island separ ted by wid and shall w seas, probably represe ts th f rm r tate f Eur ope whilst most of r f rm tions w re ac cum lati g. The Malay Arch pelago is o of the richest regi ns in rgani being t if *all* th species were to b collected which h er h ed there h w mperfectly w ld th y represent th natural hist ry f th w ld

B t w ha e ery reason to bel th t the terrestrial prod ctions of th archipelag ould be preserved an trem ly mperfect mann in th f rmat ons which w ppose to be th re accumulating N t many f the

sed ment did ot accum lat the bed of the sea, where t did not accumulate t a ffic t rate to protect rgan bod es from decay no remains co ld be preserved.

F rmations rich in fossils of many kinds, and of th kness ffic t to last to an age as distant in f turity as th seco dary f rma tions lie in the pa t, w ld g rally be f rmed in the arch pelago ly d ring period f b sidence. Th se periods f b id nce w ld be separated from ach th by imm nse inte als of t m during which the are would be eithe tationary rising whilst rising, th fossiliferous f rmations on th teeper sh res would be destroyed, almost as soo as accum lated, by th incessant coast action, as now see on the sh res of South Am rica. E en throughout the tensi and shallow seas th in the arch pelago, sedim tary beds could hardly be accum lated of gre t thickness dur ing the period of le tion, becom capped and protected by subseq t deposits, so as to ha g l lance f nd ring to ry dis tant f ture D ring th periods of bsidence there ould probabl be much extinction of lif during the periods of le tion, th re ould be much ariatio b t th geological record ould then be less perfect.

It may be doubted h the the d ration of any o great period f s bsidence over the wh le or part of the archipelago, togeth r w th a co t mporaneous accumul t n of sed ment w uld *exceed* th a d ratio n of the same specific forms and these co tin n ies are in dispensabl f r th preservati n of all the tran t al grad ti ns b tween any two o more pecies. If such g ad ti n w re n t all f lly preserved, transitional var t es wo ld m rely ppear as so many new th ugh lo ly allied spec es. It is also probabl th t each gre t period of subsidence wo ld b inter rupted by oscillations of le l, and that l ght clim tal changes w uld interve e during such l ngthy pe ods and in these cases the n hab tants f the arch pelago would m grate d no cl sely consec ti record f th ir modificati ns could be preserved in any f rm t n.

to th beli f th t it w uld be chiefly these f ranging pecies, th gh nly som of th m wh h w ld ften t produce new var t es and the ariet s would t first be local co

diff r from th f rm tat in a nearl m f rm th h pe h p xtrem ly slight d gree and as they w uld be f und mbedded n sl ghtly diff re t b- ta s f th sam forma ti n, th y w ld according to th p inc ples f llo ed by many palæont l gists, be ranked as new and disti t speci s.

If th n th re b som d gree of truth in these rema ks, we ha n right t expect to find n geological f mations, an nfin te n mbe f th ose fi transiti nal f ms which on ou theory have connected all th past and prese t species f th same group into on lo g and branching chai of life W o gl t nly to look f r a f w links, and uch assuredly w d find—som more distantly some m re losely lated to ach ther and these link let th m be so lose if f d differe t tages f th same f rm t n, w uld by many palæo tol gists, be ranked as distinct pec s B t I d not pretend that I sh uld ever ha pected how poo was th record in th be t preserved geological sections, had not the ab sence of m rable trans tional links be tween th pecies which l ed at th com

the very fine species of D Orbigny and others into the rank of varieties and on this view we do find the kind of evidence of change which on the theory we ought to find Look again at the later tertiary deposits which include many shells believed by the majority of naturalists to be identical with existing species but some excellent naturalists as Agassiz and Pictet maintain that all the tertiary species are specifically distinct though the distinction is admitted to be very slight so that here unless we believe that these eminent naturalists have been misled by their imaginations and that these late tertiary species really present no difference whatever from their living representatives or unless we admit in opposition to the judgment of most naturalists that these tertiary species are all truly distinct from the recent we have evidence of the frequent occurrence of slight modifications of the kind required It we look to rather wider intervals of time namely to distinct but consecutive stages of the same great formation we find that the embedded fossils though universally ranked as specifically different yet are far more closely related to each other than are the species found in more widely separated formations so that here again we have undoubted evidence of change in the direction required by the theory but to this latter subject I shall return in the following chapter

With animals and plants that propagate rapidly and do not wander much there is reason to suspect as we have formerly seen that their varieties are generally at first local and that such local varieties do not spread widely and supplant their parent forms until they have been modified and perfected in some considerable degree According to this view the chance of discovering in a formation in any one country all the early stages of transition between any two forms is small for the successive changes are supposed to have been local or confined to some one spot Most marine animals have a wide range and we have seen that with plants it is those which have the widest range that oftenest present varieties so that, with shells and other marine animals, it is probable that those which had the widest range far exceeding the limits of the known geological formations in Europe have oftenest given rise first to local varieties and ultimately to new species and this again would greatly lessen the chance of our being able to trace the stages of transition in any one geological formation

It is a more important consideration leading to the same result as lately insisted on by Dr Falconer namely that the period during which each species underwent modification, though long as measured by years, was probably short in comparison with that during which it remained without undergoing any change

It should not be forgotten that at the present day with perfect specimens for examination two forms can seldom be connected by intermediate varieties and thus proved to be the same species until many specimens are collected from many places and with fossil species this can rarely be done We shall, perhaps best perceive the improbability of our being enabled to connect species by numerous fine intermediate fossil links by asking ourselves whether for instance geologists at some future period will be able to prove that our different breeds of cattle sheep horses and dogs are descended from a single stock or from sev

gists as distinct species from their European representatives and by other conchologists as only varieties are really varieties or are as it is called specifically distinct This could be effected by the future geologist only by his discovering in a fossil state numerous intermediate gradations and such success is improbable in the highest degree

It has been asserted over and over again by writers who believe in the immutability of species that geology yields no linking forms. This assertion as we shall see in the next chapter is certainly erroneous. As Sir J Lubbock has remarked Every species is a link between other allied forms If we take a genus having a score of species, recent and extinct and destroy four fifths of them no one doubts that the remainder will stand much more distinct from each other If the extreme

research has not revealed is the former existence of infinitely numerous gradations, as fine as existing varieties connecting together nearly all existing and extinct species. But this ought not to be expected yet this has been repeatedly advanced as a most serious objection against my views

It may be worth while to sum up the foregoing remarks on the causes of the imperfec

tio of the geol g cal ecord nd r n m g mary ll trati Th Malay A l p l g is al t the ize of E rope fr m th N rth C p to tl e M d t rra ea and from Brita n to R ss and th r f re equ ls all tl geol gi al f m t ns h ch h bee m d with any accu acy e c pt g th e f tl U t d S t f Am r a. I f lly g e tl Mr God

represe t th n tural h tory f tl wo ld! B t w ha e ry re son to b l e th t the terrest al p od ts of tl a h pel g ld b preserved n xt m ly mp fect mann r in th f rm t wh h w pp se to be th accumulat g N t many f th

of the sea, wh it d d n t ac m l te t a ffi t te to protect g bod es fr m d cay mains co ld b p rv d F mat ns rich f l f many kinds and f th kn ss ffici t to last to an g as distant f t ty as tl ec dary f ma-tions h in th past, w ld g ally be formed in the a cl pel g ly d n g p riod f b-id ce. Th se p od f b d ld b separated from ch the by mm t r

w ld b d t yed alm t as soo as accumu lat d by th ssant coast act as w w see th sh re f So th Am ca. E en thro gh t tl e tens e and hall w seas th tl arch pel g sed m tary bed co ld hardly be accum l ted f great th ck ss d ing tl period f l t on bee m e pp d and p tected l y bseq t d po ts, so as to ha good l ce f duri g to y d s-tant f t D g the p ods f b idence, th re ld prob bly be m ch exti ct f lif d ing tl p od f l t n th ld b m l ar tio b t th geological ecord ll tl be less perfect.

It may be d bted wh th th d ti of a y gre t p iod f s l lence over the wh l o p rt of the a cl p l g tog ther with c ntempor eous acc m l tion f s d ment wo ld *e c d* the a rage dt ation f tl e s me spec fic f *ms* ar l th se co ti g nces a e in d spen l le for tl e pr servation of all tl e t an t l g adat ons b tween any tw or mo spec If uch g ad t s we e n t ll *f* ll preserved t an tion l vari ties v uld

cl m tal l g w ld te vene d ing s h l ngtl y per ods and in th se case tl e in l ab tant f tl arcl pel go would m g te nd cl sely on ecuti ord of th r mod ficat o s could be preserved in any one form t o

A y m y f tl e n arc e inl l t nt of tl e arcl p l g n ge th us nds f m les b y nd ts confi e nd logy pla ly l d to the b lief tl t t w uld b ch fly th se f ng g peci s th gh only some of them wh h w ld ften t prod new var t s

plant th p ent f m When uch var t r t rn d to tl e t home as they wo ld d ff r f om tl f m r state a n a ly un f m tl gl pe h ps t em ly l ght degree and as th y w uld be *fo d mb dded in* l ghtly d fferent b stag f th m f ma ti n they w ld c d g to th p pl s f ll d by m y p laeont l gists be a ked as new d d st ct sp es

If th tl be s m d g e of truth in these rem rks w ha e right t pect to find n u geol cal f rm t s, an fi t n mb f tl fi t a s t n l f m which ur theory h onn cted all th p t and prese t pec es f tl same g oup into e l g and b l g h n f lif W o gl t nly to look f f w l ks an l uch ass edly w d fi d—som m d t ntly some m l sely l ted to ach th and the e l k let th m b so l se if found d ff t tages f th m f m t w ld by many

p ese ed geol g al ct s, had n t tl e ab se ce f m bl t an t l links be t een tl e pec l ch l ed t th com

the very fine species of D'Orbigny and others into the rank of varieties; and on this view we do find the kind of evidence of change which on the theory we ought to find. Look again at the later tertiary deposits, which include many shells believed by the majority of naturalists to be identical with existing species; but some excellent naturalists, as Agassiz and Pictet, maintain that all these tertiary species are specifically distinct, though the distinction is admitted to be very slight; so that here, unless we believe that these eminent naturalists have been misled by their imagination, and that these late tertiary species really present no difference whatever from their living representatives, or unless we admit, in opposition to the judgment of most naturalists, that these tertiary species are all truly distinct from the recent, we have evidence of the frequent occurrence of slight modifications of the kind required. If we look to rather wider intervals of time, namely, to distinct but consecutive stages of the same great formation, we find that the embedded fossils, though universally ranked as specifically different, yet are far more closely related to each other than are the species found in more widely separated formations; so that here again we have undoubted evidence of change in the direction required by the theory; but to this latter subject I shall return in the following chapter.

With animals and plants that propagate rapidly and do not wander much, there is reason to suspect, as we have formerly seen, that their varieties are generally at first local; and that such local varieties do not spread widely and supplant their parent forms until they have been modified and perfected in some considerable degree. According to this view, the chance of discovering in a formation in any one country all the early stages of transition between any two forms, is small, for the successive changes are supposed to have been local or confined to some one spot. Most marine animals have a wide range; and we have seen that with plants it is those which have the widest range, that oftenest present varieties; so that, with shells and other marine animals, it is probable that those which had the widest range, far exceeding the limits of the known geological formations in Europe, have oftenest given rise, first to local varieties and ultimately to new species; and this again would greatly lessen the chance of our being able to trace the stages of transition in any one geological formation.

It is a more important consideration, leading to the same result, as lately insisted on by Dr. Falconer, namely, that the period during which each species underwent modification, though long as measured by years, was probably short in comparison with that during which it remained without undergoing any change.

It should not be forgotten, that at the present day, with perfect specimens for examination, two forms can seldom be connected by intermediate varieties and thus proved to be the same species, until many specimens are collected from many places; and with fossil species this can rarely be done. We shall perhaps best perceive the improbability of our being enabled to connect species by numerous, fine, intermediate, fossil links, by asking ourselves whether, for instance, geologists at some future period will be able to prove that our different breeds of cattle, sheep, horses, and dogs are descended from a single stock or from sev

gists as distinct species from their European representatives, and by other conchologists as only varieties, are really varieties, or are, as it is called, specifically distinct. This could be effected by the future geologist only by his discovering in a fossil state numerous intermediate gradations; and such success is improbable in the highest degree.

It has been asserted over and over again by writers who believe in the immutability of species, that geology yields no linking forms. This assertion, as we shall see in the next chapter, is certainly erroneous. As Sir J. Lubbock has remarked, "Every species is a link between other allied forms." If we take a genus having a score of species, recent and extinct, and destroy four-fifths of them, no one doubts that the remainder will stand much more distinct from each other. If the extreme

researches has not revealed the former existence of infinitely numerous gradations, as fine as existing varieties, connecting together nearly all existing and extinct species. But this ought not to be expected; yet this has been repeatedly advanced as a most serious objection against my views.

It may be worth while to sum up the foregoing remarks on the causes of the imperfec

taml fi ed during the deposition of the upper greensand and still m re recentl that strange bird, the Archeopteryx, with long lizard like tail, bearing a pair of feath rs on each joint, and with its wings furnished with two free cla s has been disco red in the oolitic slates of Solenhofen. Hardly any recent disco rs shows more forcibly than this, how little w as yet know of the f rmer inhab tants of th w rld.

I may giv an th instance which, from ha ing passed und my an es, has much truck me. In memoir O Fossil S ssile Cir ri eds, I stated that, from th large number of existin and extinct t rtiary species from th traordinary abundance f the indi iduals of man species al er th world, from the Arctic regions t th equato inhabiting ari ous zones of depths from th ppe tidal limits to 0 fathoms from the perfect mann in hich specimens are preserved in the oldest tertiary beds from th ease w th which even a fragment of al can be recognised from all these circumstances, I inf rred that, had sessile cirripedes existed during th secondary periods, th would certainly ha been preserved and disco red and as not ne species had then been disco red in beds of this a I concluded that this great group had been suddenly de loped t the commencem nt of the tertiary series. This was sore trouble to me, adding as I then thought o more instance of the abrupt ppearance of great gro p of species. B t my work had hardly been published, be skilful palæontologist, M. Bosquet, sent m dra ing of perfect pecim n of an unmistakable sessile cirriped which h had himself tracted from the chalk of Belgium. And, as if to make th case as triking as possible, this cirriped was Chthamalus, ery common, lar and ubiquitous g nus, of which not one species has as t been found en in an tertiary str tum. till more recently I r ma, membe of distinct subfamil of sessile irripedes, has been disco ered by M Wood ard in the pper chalk so that now ha abundant idence of the ex istence of this group of animals during the secondary period

The case most frequentl insisted on by palæontologists of the pparentl sudden ppearance of hole group of pecies, is that of the leostran fishes, low down, according to Agassiz, in the Chalk period. This group includes the lar e majority of existing species. B t certain Jurassic and Triassic forms are no commonly admitted to be teleostean and even som palæozoic forms ha thus been classed by o e hi h uth rit If the teleosteans had really appeared suddenly in the northern h misph re at the commencem nt of th chalk f rmation the fact would ha been highl remarkable but t would n t ha e formed an ins perable difficulty unless t could likewise ha been shown that t the sam period th pecies w re udd nl and simultaneously d l ped in other quarters of the w ld. It is almost superfluous to remark that hardl any fossil-fish are known from south of the equato and by running thro gh Pictet s *Palæ ntology* it will be seen th t ry f w speci are known from several f rmations in Europe. Som few families of fish now ha e a confined ran the t leo tean fishes might f rm rly have had a similarly confined range and after having been larg ly d eloped in some one sea, ha pread wid ly Nor ha we any right to ppose that th seas of th w ld ha alw ys been so freely open from so th to north as th y are t present. Even t this day if the Malay Arch pelago w re con rted into land, the tropical parts f th Indian Ocean would form a lar and perfectly enclosed basin, in which any great group of marin ani mals might be multiplied and h re th y would remain confined, until some of the species be cam ad pted to cool limat and w re en abled to d ubl the So th rn cape of Africa r Australia, and thus reach th r and distant seas.

From these considerations, from our gnor ance of th geology of th countri s be nd th confines of Europe and th United States, and from the re ol tio in our palæontological knowled ffected by th disco ries of the last dozen years, t seems to m to be about as rash to d gm tize n th succession of organic f rms throughout th w rld, as t would be for naturalist to land f fi minut n a bar ren point in Australia, and then to discuss the numbe and rang f ts productions.

On the sudden Appearance of Groups of al l ed Species n the l w st known Fossi l ferous Strata

There is anothe and allied difficult which is much more serious. I allud to th mann in which pecies belonging to se ral of th main di isions of th animal king d m sudd nly ppear in the lo est kn wn fossiliferous rocks. Most of the argum nts which ha con inced m that all th existing species of the sam gro p are descended from a single progenitor

mencement and close of each formation pressed so hardly on my theory

On the sudden Appearance of whole Groups of allied Species

The abrupt manner in which whole groups of species suddenly appear in certain formations has been urged by several palæontologists—for instance by Agassiz Pictet and Sedgwick—as a fatal objection to the belief in the transmutation of species If numerous species belonging to the same genera or families have really started into life at once the fact would be fatal to the theory of evolution through natural selection Fo tl

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... tiate the perfection of the geological record and falsely infer because certain genera or families have not been found beneath a certain stage that they did not exist before that stage In all cases positive palæontological evidence may be implicitly trusted negative evidence is worthless as experience has so often shown We continually forget how large the world is compared with the area over which our geological formations have been carefully examined we forget that groups of species may elsewhere have long existed and have slowly multiplied before they invaded the ancient archipelagoes of Europe and the United States We do not make due allowance for the intervals of time which have el psed between our con ecutive formations —longer perhaps in many cases than the time required for the accumulation of each formation The e intervals will have given time for the multiplication of species from some one parent form and in the succeeding formation such groups or speci s will appear as if suddenly created

I may here recall a remark formerly ma le namely that it might require a long succe n

forms would often long remain conf ned to some one region but that wh n this a lapta tion had once been effected and a f w pecies

throughout the world Profe sor P ctet, in his excellent review of this work in commentin on early tran itional forms, and taking birds as an illustration cannot see how the successive modifications of the anterior limbs of

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... ap along the surface of the sea like the logger headed duck and ultimately to rise from its surface and glide through the air?

I will now give a few examples to illustrate the foregoing remarks and to show how liable we are to error in supposing that whole groups of species have suddenly been produced Even in so short an interval as that between the first and second editions of Pictet s great work on *Palæontology* published in 1844–46 and in 1853–57 the conclusions on the first appearance and disappearance of several groups of animals have been considerably modified and a third edition would require still further changes I may recall the well known fact that in geological treatises, published not many years ago mammals were always spoken of as having abruptly come in at the commencement of the tertiary series And now one of the richest known accumulations of fossil mammals belongs to the middle of the secondary series and true mammals have been discovered in the new red sandstone at nearly the commencement of this great series Cuvier used to urge that no monkey occurred in any tertiary stratum but now extinct species have been discovered in India,

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the new red sandstone of the United States, who would have ventured to suppose that no less than at least thirty different bird like animals some of gigantic size existed during that period Not a fragment of bone has been discovered in these beds Not long ago palæontologists maintained that the whole class of birds came suddenly into existence during the eocene period but now we know on the authority of Professor Owen that a bird cer

taml h ed during th depo ti n f th uppe greensand and till m re rece tly that strange b d, the Archeopte x with l g lizard lik tail, bearing a pai of feath rs n each j int, and with ts wings furnished with two free claws, has been disco red in the oolitic slate of Sol nh fen. Hardly any recent disco rs sh ws m re f rcibly than this, h w littl we as t know of th f rmer inhab tants f the w ld.

I may g an th in tance wh ch, from ha ing passed und my wn y s, has m ch truck m In a m m ir O *Fossil S ile Cir ri* I tated that, from th la g n mb f existing and extinct t rtiary species from th traordinary abundance f th ind duals of many pecie all th w ld, from th *Arctic regions* to th equato inhab ting vari ous zo es of depths from th ppe tidal limit to 0 f th ms from th perfect mann in hich pec m ns are preserved in th ldest tertiary beds from th ase w th lhich n a fragm t of al can be recognised from all these circumstances, I inf rred that, had sessile cirripedes xisted during th seco dary periods, th y w uld certainly h e been preserved and disco red and as ot species had then been disco red in beds f this ag I o luded that this great gro p had been d denly d loped t th comm cem t of th t rtiary series. This as sore tro bl t me, add as I th t ght n m re instance f the abrupt ppearance f reat gro p f p cies. B t m w k had hardly been p blis d, wh skilf l palæo tol gist, M. Bos q t, se t m dr g I perfect pecim n f an unmistakabl sessile cirripede, which h had himself xtracted from th chalk f B l gium. And, as if to mak th case as triking as possible, this cirriped as Chthamalus, ry comm n, larg and ub quitous g us, of hich t pecies has as y t been f und in an t rtiary tr tum. Still m re re tl l rg ma, m mbe of distinct subfam l of sess l ir ped s, has been disco red by M Woodward in th pe chalk so that now h abundant id nce f th existence of this gro p of animals durin th secondary pe iod.

Th case most freq tl insi ted n by

cludes th lar m jority f t g spec s. B t ertain Jurassic nd Triass f rms ar now commonly adm tted t be teleo t an and e n some palæozo c f rms hav thus been classed by o e hi h uth rity If the t l osteans had really appeared s dd nly in th n thern h misph re t th commencem nt of the chalk f rmat n th fact w uld h e been hi hly remarkable but it would n t ha e f rmed an ins perable difficulty unless it could lik wise h been shown that t the same per od the pecies were ddenly and simultaneo sly d l ped in other quart rs f th w ld It is almo t pe fl us to remark that hardly any f ss l fish are kn wn from so th f the equ to and by running thro gh P tet s *Palæ tology* it will be seen th t ery f w pec s are kno n from se eral f rm tions in Europe. Some few families f fish now have a confi ed ran th t leo t an fishes m l t f m rly h ve had a similarly confi ed range and aft ha ing been larg ly d loped in som sea, ha pread w d ly N ha e w any right to ppose that th seas of th wo ld ha alw ys been so freely pe from so th to n rth as th y are t present. E n t thi d y if the Mal y Arch pelago w re con erted into land the trop cal parts of the Indian Ocean would f rm larg and perfectly ncl sed basin in which any great group f m rine animals m ght be multiplied and h re they would remain confined until som of the species be came ad pted t cool climat and w n abled t d ubl the South n cape f Africa Australia, and thus reach th r and distant seas.

From these consid rat ns, from ur gn ance f the geol gy of ther co tr b y nd th confin s f Europe and the United States, and from th re ol ti in ur palæo t log al kn ledg ffected by th disco ri f th last d zen y ars, t seems t m t be abo t as ash to d gm tiz n th ccess n f rgani f rms through ut th wo ld as t w uld be for naturalist to land f fi e min t n a barren point in Aust al a, and th n to discuss the number and rang f ts prod cti ns.

On the sudden Appearance of G oups of al l ed Species i the low st k i wn Fossiliferous St ata

Th re is an th and allied diffi lty which is m ch m re seri us. I all d to the mann in whi pec es bel ging to se al of th m in d isi ns of th animal kingd m dd nly ppear in the low t kn wn f ssilif rous ocks. Most f th argum ts wh ch h con inced m that all th tin pecies of th sam gro p are d sce ded from si gl progenito

apply with equal force to the earliest known species For instance it cannot be doubted that all the Cambrian and Silurian trilobites are descended from some one crustacean which must have lived long before the Cambrian age and which probably differed greatly from any known animal Some of the most ancient animals as the Nautilus, Lingula &c do not differ much from living species and it cannot on our theory be supposed that these old species were the progenitors of all the species belonging to the same groups which have subsequently appeared fo they are not [illegible] racter [illegible] true it is [illegible] t Cambrian [illegible] elapsed as long as or probably far longer than the whole interval from the Cambrian age to the present day [illegible] ods the [illegible] Here we [illegible] seems [illegible] whether the earth in a fit state for the habitation of living creature has lasted long enough Sir W Thompson concludes that the consolidation of the crust can hardly have occurred less than 20 or more than 400 million years ago but probably not less than 98 or more than 200 million years These very wide limits show how doubtful the data are and other elements may have hereafter to be introduced into the problem Mr Croll estimates that about 60 million years have elapsed since the Cambrian period but this judging from the small amount of organic change since the commencement of the Glacial epoch appears a very short time for the many and great mutations of life which have certainly occurred since the Cambrian formation and the previous 140 million years can hardly be considered as sufficient for the development of the varied forms of life which already existed during the Cambrian period It is, however probable as Sir William Thompson insists that the world at a very early period [illegible] would have tended to induce changes at a corresponding rate in the organisms which then existed

To the question why we do not find rich fossiliferous deposits belonging to these assumed earliest periods prior to the Cambrian system I can give no satisfactory answer Several eminent geologists, with Sir R Murchison at their head were until recently convinced that we beheld in the organic remains of the lowest Silurian stratum the first dawn of life Other highly competent judges, as Lyell and E Forbes have disputed this conclusion We should not forget that only a small portion of the world is known with accuracy Not very long ago M Barrande added another and lower stage abounding with new and peculiar species beneath the then known Silurian system and now still lower down in the Lower Cambrian formation Mr Hicks has found in South Wales beds rich in trilobites, and containing various molluscs and annelids The presence of phosphatic nodules and bituminous matter even in some of the lowest azoic rocks, probably indicates life at these periods and the existence of the Eozoon in the Laurentian formation of Canada is generally admitted There are three great serie of [illegible] s rpass that of all the succeeding rocks, from the base of the palaeozoic series to the present time We are thus carried back to a period so remote that the appearance of the so-called primordial fauna (of Barrande) may by some be considered as a comparatively modern event The Eozoon belongs to the most lowly organised of all classes of animal but is highly organised for its class it existed in countless numbers and [illegible]

[illegible] ons, which I wrote in 1859 about the existence of living beings long before the Cambrian period and which are almost the same with those since used by Sir W Logan have proved true Nevertheless, the difficulty of assigning any good reason for the absence of vast piles of strata rich in fossils beneath the Cambrian system is very great. It does not seem probable that the most ancient beds have been quite worn away by denudation or that their fossils have been wholly obliterated by metamorphic action for if this had been the case we should have found only small remnants of the formations next succeeding them in age and these would always have existed in partially metamorphosed condition But the descriptions which we possess of the Silurian deposits over immense territories in Russia and in North America do not support the view that the older a formation is, the more invariably it has suffered extreme denudation and metamorphism.

Th case at present mu t remain mexplic abl and may be truly urged as a val l argu m t agam t the v e h re t rtai ed To show that t may h reafter cee e some ex planati n, I ıll gı th f ll wın hypothesis. From tl t re f th org c remains wh ch d not ı pear to h *inhab ted profo d* depths, m th seve al f rmati ns f E rope and f th United States and from tl m t of sedım t, mil ın th ckn ss, f which th f rmations are composed w m y nf r that from first to la t larg lands tracts f land, h ce tl sed m t was d rı ed occ rred ın th *ghbo hood f th w xısting co t ents* f Europe and N rth Am rıca. This sam w Las ınce been maintained bv Agas sız and th rs. B t d t kn w hat was th tate f things ın th ınt rv ls betwee th sev ral successı form t n wh tl r E rope and th United State durın th se ınt als ısted as dry land, as bmarın rf ce ar land which sed m t was n t de po ted, as th bed f an pen and unf th omal le sea.

Looki g t th ıstıng oceans, whı h are thrıce as t ns as th land w see th m t lded w th man land b t hardly trul oceanıc ısland (th th ceptı n f New Zealand, ıf this can be called truly oceanı land) as y t kn wn t aff rd n remnant f any palæo ıc secondary f matıo H nce m pe h p ınf that during th palæozo and seco dar periods, th co tın ts co tın tal land ısted wh re oceans w t nd f had they existed palæozo and seco dary f rma tıons ould all probabılıty h been ac cum lated from sed m t d rı ed from th ır ar and t ar and tl se w uld h been t least partially ph ed b th oscıllatı ns f le l, wl ıch m t ha ınt rv ed during *these* rm usly long periods. If th w m y ınf an thıng from th se facts, we m y ınf that h re oceans n w t d oceans ha t ded from tl rem test period of wl h w h any record and th th ha l that wh re co tı ts now t, larg tracts of land ha ted bjected d bt to great oscillations *f l l*, ınce th Cam b ıan period Th colo red m p ppended to m l m voral reefs, led m t co cl d that the great oceans are till maınl areas of l sıd nce the gre t rch pela oe till reas of s llat ns f l l, and th co tınents areas of le tıon. B t w h reason to assum that th gs l *tl rmaı ed from* the begınn ng of tl e w rld O r contı s seem to h v been formed b a prepo derance d ın many oscillat ons of l el, f the f rce f tı n b t m y t th areas of pre po d rant m m nt h cl an ed ın th lapse f At a period l g anteced t to th Cambrıan poch co tın ts may h existed wl re oceans are now pread ut and lear and pen ocea s m y h e ex ted where co t ts now tand N r sho ld we be ju tıfied n assumın that f f tance the bed of th Pacıfi Ocean w re no con erted t co t n t w h ld th re find sed

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m ght w ll happen tl t trata h ch had b- sıded som m l s n arc to the centre f the arth and which had been p essed on bv an rm w ght f perm ment w t r m gl t ha und r e f *m re met morph c* act n than trata which h alw ys re mained ar r to th surf ce The me se areas ın som parts f th w ld f r tance ın South Am rıca, of naked m tam rph c rocks, wl ch m t l e been h ted under gre t press re, h v lw y seemed to me t req re some special plan t n d w may pe h p beh that see ın these large ar as, tl m y f rmat ns l g antem r to the C *mbrıan pod n a compl t ly m ta- m rpl sed* and d ded co d t n.

Th se rald ffic lt c h redısc ssed nam ly —th t, tl gh we find n geol gı al f m tı ns many links betwee tl spec wh h n w xist and which f rm l xı ted w d not find ınfinıt ly num rou fin tran tıonal f rms closely y ını g th m all tog th —th dd n mann ın which se r l gro p of specı first ppear ın Europe n form tions —th almost ent re bsence as t present kn wn f f rm tıons rıch ın f s ıls be ath th Cambrıan trata,—are ll u l btedly of th most serıo nature W see thı th fact th t th most m nt palæo t lo ısts, n m ly Cu er Agassız, Barrand l t t Falco E. F rbes, &c., and all r gre test geol gısts, as Ly ll Murchıso Sedgw k, &c.

geological record ıs ın any d gree perfect, will d ubtedly t ce reject th theory F my

part following out Lyell's metaphor I look at the geological record as a history of the world imperfectly kept and written in a changing dialect of this history we possess the last volume alone relating only to two or three countries. Of this volume only here and there a short chapter has been preserved and of each page only here and there a few lines Each word of the slowly-changing language more or less different in the successive chapters, may represent the forms of life which are entombed in our consecutive formations, and which falsely appear to have been abruptly introduced On this view the difficulties above discussed are greatly diminished or even disappear

CHAPTER XI

ON THE GEOLOGICAL SUCCESSION OF ORGANIC BEINGS

LET us ow see wh th r the several facts and law relating to th geol gical uccess on f organic being accord best with th comm n view f th imm tal lity f pecies, with that of th ir low and grad al mod ficat on, thro h ariation and n tural selecti n

New species h ppeared ery l wly o e aft anoth r both the land and the w t rs I ll has sh wn th t t hardl pos-

tag s, d to mak th proport on betwce *th lost and exi tin f rm m re gradual. In*

nl tw re ew h g ppeared tl re f tl first time, th locall as far as kn th face f tl arth. Th sec ondary f rmatio re m re brok n b t, as Bro m has remarked tl th ppearance or d sappearance f th many pec es mbed ded ach f rmati has bee m ltaneo s.

Species belongi g t d ff re t g ra and la ses ha t ch ged t th sam t tl sam d gree I tl ld t tiary bed *f w living sh lls ma t ll be f und th midst* of m lt t l f tin t f rms. Falco has gi trik instance f similar fact, for an ting rocodil associated with many lost mammals and rept l in th b-Hima-l an depo ts. Th S l rian *L g l* d ff rs l t l ttle from th l species of th g hereas m t f tl th S l rian m lluscs and all th crustaceans h changed gre tly Th prod tions of th land seem t h changed t q ick rat than those f th sea, of l l trikin instance has been bserved tze land Th re som reason t beli that rganisms high in th scale, chan more q ickl than tl se that are low th b th re are xcep ns t tl is rul Th am t f g nic han as l ict t has remarked t the sam in ach ccessi so-called f ma tion. Y t if compare b t th m t closely related f rmations, all th species w ll be found t ha und rg som chan Wh species has nce disappeared from th face of the arth, w ha e n reason to believ

ru is u —

Barrande wh ch intrud f r a period n the mid t f an lde f rmatio and th all w that the pre-existing fa na to re ppear but L ll s explanat o nam ly th t it is a case f tem porary m grat from a distinct geograph cal pro ince seem satisfact ry

Th se se ral facts ccord w *ll with our* theory which incl des no fixed law f d l p-m nt c ing all th nhab tants f an area to chan brupth r multaneou ly o to an eq al d gree Th process f mod ficat n must be low and will g n rally ffect nly a f w speci t th sam t m f th ariab l ty of ach spec es s ind pend t f th t f all th rs. Wh th h ari t ns o nd d al d ff ences as m *y arise w ll be accumulated through* nat ral select on in a great l ss d gree, th ca in greate less mo nt of pe man t mod fication, will d pend on many complex co ting ci —on th ari t ns be-in of be ficial n t re n th freed m f int rcrossi on th l wly changin phy ical cond t ns f th country n the imm grat on f w col n ts, and n th nature f th th r *inhab ta ts with which the* arv pec s com into compet t n. H ce t is by n m ans surprisin th t spec es sh ld retain the sam d nt cal f m m h lon than oth rs o if chan g h ld chang in a less d gree. W find m la rel t ns between th xisting inhab tants f d tin t countri f r instance, th land sh ll and coleopt ro insects f Mad ra h com t diff cons d rably from th n arest allies n th contin t of Europe, wh reas th marin sh lls and b rds h re-mained unaltered W can perh ps u d tand th pp rentl quick rate f hang in te restrial and in m re h hly ganised pro-d t ns compared with marin and l w r

area ha becom modified and impro ed w can nd rstand n th pri pl of compet ti n, and from th all- mportant relat ns of organism to rganism in th trug le f life,

that any form which did not become in some degree modified and improved would be liable to extermination. Hence we see why all the species in the same region do at last, if we look to long enough intervals of time, become modified, for otherwise they would become extinct.

In members of the same class the average amount of change during long and equal periods of time may perhaps be nearly the same; but as the accumulation of enduring formations, rich in fossils, depends on great masses of sediment being deposited on subsiding areas, our formations have been almost necessarily accumulated at wide and irregularly intermittent intervals of time; consequently the amount of organic change exhibited by the fossils embedded in consecutive formations is not equal. Each formation, on this view, does not mark a *new and complete act of creation, but only an* occasional scene, taken almost at hazard, in an ever slowly changing drama.

We can clearly understand why a species when once lost should never reappear, even if the very same conditions of life, organic and inorganic, should recur. For though the offspring of one species might be adapted (and no doubt this has occurred in innumerable instances) to fill the place of another species in the economy of nature, and thus supplant it; yet the two forms—the old and the new—would not be identically the same; for both would almost certainly inherit different characters from their distinct progenitors; and organisms already differing would vary in a different manner. For instance, it is possible, *if all our fantail pigeons* were destroyed, that fanciers might make a new breed hardly distinguishable from the present breed; but if the parent rock pigeon were likewise destroyed, and under nature we have every reason to believe that parent forms are generally supplanted and exterminated by their improved *offspring, it is incredible* that a fantail, identical with the existing breed, could be raised from any other species of pigeon, or even from any other well established race of the domestic pigeon, for the successive variations would almost certainly be in some degree different, and the newly formed variety would probably inherit *from its progenitor* some characteristic differences.

Groups of species, that is, genera and families, follow the same general rules in their appearance and disappearance as do single species, changing more or less quickly, and in a greater or lesser degree. A group, when it has once disappeared, never reappears; that is, its existence, *as long as it lasts,* is continuous. I am aware that there are some apparent exceptions to this rule, but the exceptions are surprisingly few, so few that E. Forbes, Pictet, and Woodward (though all strongly opposed to such views as I maintain) admit its truth; and the rule strictly accords with the theory. For all the species of the same group, however long it may have lasted, are the modified descendants one from the other, and all from a *common progenitor.* In the genus *Lingula,* for instance, the species which have successively appeared at all ages must have been connected by an unbroken series of generations, from the lowest Silurian stratum to the present day.

We have seen in the last chapter that whole groups of species sometimes falsely appear to *have been abruptly developed; and I have* attempted to give an explanation of this fact, which if true would be fatal to my views. But such cases are certainly exceptional; the general rule being a gradual increase in number, until the group reaches its maximum, and then, sooner or later, a gradual decrease. If the number of the species included within a genus, or the number of the genera within a family, be represented by a vertical line of varying thickness, ascending through the successive geological formations, in which the species are found, the line will sometimes falsely appear to begin at its lower end, not in a sharp point, but abruptly; it then gradually thickens upwards, often keeping of equal thickness for a space, and ultimately thins out in the upper beds, marking the decrease and final extinction of the species. This gradual increase in number of the species of a group is strictly conformable with the theory; for the species of the same genus, and the genera of the same family, can increase only slowly and progressively; the process of modification and the production of a number of allied forms necessarily being a slow and gradual process,—one species first giving rise to two or three varieties, these being slowly converted into species, which in their turn produce by equally slow steps other varieties and species, and so on, like the branching of a great tree from a single stem, till the group becomes large.

On Extinction

We have as yet only spoken incidentally of the disappearance of species and of groups of species. On the theory of natural selection, the extinction of old forms and the production of

new and improved f rms are t mat lv con nected tog th The ld n tion f all th in hab tants of th earth ha ing been swept w y by catastrophes t ccessi e pe od is ry generally gi en p, en by those geologists, as Eli de Beaum t, M rch so Barrande, &c., whose g eral views w ld natu ally lead them to this conclusion. On th contrary we ha ery reason to beli e, from th tud of the tertiary f rmations, that peci and gro ps of species graduall disappear afte an ther fi t from n spot, th n from anoth and finally from th wo ld. In some f w case h w er as by th breaking of an isthmus and th conseq ent irrupti n f a m lt tud of new inhab tants into an adj ining sea, by th final ubsidence of an island th process f extinctio may ha been pid Both ingle pecies and wh l gro p of pecies last f r ery unequal period som gro ps, as w ha seen, ha nd red from the arliest known dawn of lif t th prese t d som h disappeared bef re th close of the palæozoic period. N fixed law seems to d t rmin the length of tim during hich an gl speci or any single g n ndures. Th re is reason to belie th t the xtinctio of wh gro p f species is ge erall slow process than th ir productio if th ir ppearance and disappearance be represented as bef re by a rt cal line of arying th ckness th line is f und to tape *more graduall t its ppe nd*, which marks the progress of ext rmination, than at its lo er nd which marks th first ppearance and th early crease in umbe of th pec es. In som ases, h th t rm natio of ho groups, as f mm n tes, t ward th close of th sec ndary period, has been w n-d rfull udd

Th tinction of pec es has been in l ed th most gratuitous myst ry Som thors have en supposed that, as th indi idual has d finite length of life, so ha species d finite duratio No can ha marv lled more than I h d t th tinction of pecies. Wh I found in La Plata th tooth f horse mbedded with th remains of *Mastodon*, *M gatheri m Toxodon*, and th tinct monsters, wh ch all co-existed th still li ing shells t ery lat geological period, I was filled w th ast nishment f seeing that th horse since ts introductio by the Spaniard int South Am rica, has run ild er th hole country and has increased mbers at an *unparall led* rat I asked myself what could so recently ha t minated the forme h rse und r cond tions of life app rently so fav urabl B t my ast nishm nt was grou d less. Professor Owen soo perce ed th at the tooth tho gh so like that of the existi horse, bel ged to an xt ct pecies. *Had this horse* been till li ing, b t n some degree rare no nat alist w uld ha f lt th l ast surprise at t rarit f r rarit is the ttrib t of a va t numbe f specie of all classes, in all countries. If w ask urselves why this that species is rare w answer that som thing is un f ourabl in ts conditi ns of lif but what th t som thing is w can *hardly* r t ll. On the upposit o of th fossil h rse till existing as a rare spec es, we m ght h f lt certain, from the anal gy f all th r mammals, e en of the low breeding l phant, and from the hist ry of the naturalisation f the domestic h rse in South Am rica, that und r more f v urabl conditi ns it would in a ry f w years ha stocked the whol *continent*. But we could n t h e t ld wh t th unfa o rabl conditions w re which checked ts increase wh th som on or sev ral contingenci s, and t what period of th horse lif and in what degree they sev rally acted. If the co di ti ns had gon h w r slowly becoming less and less f ourable w assuredly should n t ha perce ed th fact, y t the fossil h rse w ld certainly ha becom rare and rare and finally extin t — ts place b ing *seized* n b some m re *ccessful* compet t

It mo t difficult alwa to rem mber that the crease of e y creature is con tantly bein checked b u perce ed l t le nc and that these sam unpe cei ed ag ncies are mply uffi nt to cause rarity nd finally extin tion. So l ttle is this subject understood that I ha h ard urprise repeatedl pressed t ch gre t m n t rs as th Masto-d n and th m re anci t dinosaurians ha ing becom extin t as if m re bodil strength ga ict ry in the b ttle of life. M re size n the contrary would in some cases d termin as has been remarked by Ow n, quick *terminatio* from th great am unt f requi sit food. Before man inhab ted India Africa som cause must ha checked th co ti ued increase f th isting l phant A highly capabl judge, D Falco e bel es th t t is chiefly insects which, from incessantly harassing and w ak ning the l phant in India, check ts increase and this was Bruce co clusion with respect to th African lephant n Abyssinia. It is certain that insects and blood sucking bats d termine the xistence f th

larger naturalized quadrupeds in several parts of S. America.

We see in many cases in the more recent tertiary formations that rarity precedes extinction; and we know that this has been the progress of events with those animals which have been exterminated, either locally or wholly, through man's agency. I may repeat what I published in 184[illegible], namely, that to admit that species generally become rare before they become extinct—to feel no surprise at the rarity of a species, and yet to marvel greatly when the species ceases to exist, is much the same as to admit that sickness in the individual is the forerunner of death—to feel no surprise at sickness, but, when the sick man dies, to wonder and to suspect that he died by some deed of violence.

The theory of natural selection is grounded on the belief that each new variety and ultimately each new species, is produced and maintained by having some advantage over those with which it comes into competition; and the consequent extinction of the less favoured forms almost inevitably follows. It is the same with our domestic productions: when a new and slightly improved variety has been raised, it at first supplants the less improved varieties in the same neighbourhood; when much improved it is transported far and near, like our short-horn cattle, and takes the place of other breeds in other countries. Thus the appearance of new forms and the disappearance of old forms, both those naturally and those artificially produced, are bound together. In flourishing groups, the number of new specific forms which have been produced within a given time has at some periods probably been greater than the number of the old specific forms which have been exterminated; but we know that species have not gone on indefinitely increasing, at least during the later geological epochs, so that, looking to later times, we may believe that the production of new forms has caused the extinction of about the same number of old forms.

The competition will generally be most severe, as formerly explained and illustrated by examples, between the forms which are most like each other in all respects. Hence the improved and modified descendants of a species will generally cause the extermination of the parent species; and if many new forms have been developed from any one species, the nearest allies of that species, i.e. the species of the same genus, will be the most liable to extermination. Thus, as I believe, a number of new species descended from one species, that is a new genus, comes to supplant an old genus, belonging to the same family. But it must often have happened that a new species belonging to some one group has seized on the place occupied by a species belonging to a distinct group, and thus have caused its extermination. If many allied forms be developed from the successful intruder, many will have to yield their places; and it will generally be the allied forms, which will suffer from some inherited inferiority in common. But whether it be species belonging to the same or to a distinct class, which have yielded their places to other modified and improved species, a few of the sufferers may often be preserved for a long time, from being fitted to some peculiar line of life, or from inhabiting some distant and isolated station, where they will have escaped severe competition. For instance, some species of *Trigonia*, a great genus of shells in the secondary formations, survive in the A[illegible]

[illegible]

a group is generally, as we have seen, a slower process than its production.

With respect to the apparently sudden extermination of whole families or orders, as of trilobites at the close of the palæozoic period and of ammonites at the close of the secondary period, we must remember what has been already [illegible]

[illegible]

slow extermination. Moreover, when by sudden immigration or by unusually rapid development, many species of a new group have taken possession of an area, m[illegible] of the older [illegible] in a cor[illegible] the forms [illegible] [illegible]aces will commonly be allied, for they will partake of the same inferiority in common.

Thus, as it seems to me, the manner in which single species and whole groups of species become extinct accords well with the theory of natural selection. We need not marvel at extinction; if we must marvel, let it be at our own presumption in imagining for a moment that we understand the many complex contingencies on which the existence of each species depends. If we forget for an instant that each species tends to increase inordinately, and that some check is always in action, yet

seldom perceived b us, the whole economy of nature will be tt rl obscured. When we can precisel say why this species is more abundant in individuals than that why this species and not anoth can be naturalised in a g en country then, and not until then, we ma justly feel surprise why we cannot account for the extinction of any particular species or group of species.

On the Forms f L fe cha ging almost simultaneously thro ghout the World

Scarcely any palæontological disco ery is more strikin than th fact that th forms of lif chang almost simultaneously thro ghout the world. *Thus our European Chalk f rmation can be recognised in many distant regions,* under the most different climates, where not a fragment of th min ral chalk itself can be found namely in N rth America, in equat rial South America, in Tierra del F ego, t the Cape of Good Hope and in th peninsula of India. For at these distant points, th rganic remains in certain beds present an unmistakable resemblance to those of the Chalk. It is not that th sam species are m t with f in some cases not n species is id ntically the same, b t th y belong to th sam families, genera, and sections of genera, and som times are similarl charact rised in su h triflin points as m re superficial sculpture M reo ther forms, which are not f und in th Chalk of Europe b t hich occur in th formations either abo below occur in the sam order at these distant points of th w rld. In th several acces palæozoic formations f Russia. West rn Europe, and North America, similar parallelism in th forms of lif has been observed b several thors so t is, ac cord ng to Ly ll th th E ropean and North American tertiary deposits. E en if th few fossil species which are common to tl Old and N w Worlds ere kept wholl o t of w th general paralleli m in the successi forms of life, in the palæozoic and t rtiary tages, ould still be manifest, and the se ral formations could be easil correlated.

These observ tions, bo relat to the marine inhabitants of th world w ha not ficient data to judg heth th produc tions of the land and of fresh w t t distant points change th sam parall l manne W ma doubt heth tl ha th hanged if the *M galeri m Mylod Macrauchen a,* and *Toxod* had been brou t t Europe from La Plata, w hout any informatio in regard to th ir geological position, o one would ha e suspected that th had co-existed with sea-shells ll ll t ll li ing b t as these anomalous

... sta es.

When th marine forms of lif are spoken of as having changed simultaneou ly thro gh ut the world t must not be pposed that this expression relates to th sam yea to the sam century n that t has a ery trict

... resembled mo t closely those of th so th rn hemisph re So, again, se ral h ghly competent observers maintain that the xisting pro d ctions of tl United States are m re closely related to those which li ed in Europe duri g *certain lat t rtiary ta es, than to the present* inhab tants of Europe and if this be so, t is id nt that fossilif rous beds w d pos ted on the shores of N rth America w uld h re after be liabl to be classed w th som what older E ropean beds. Ne erth less, looking to remot ly f t re epoch, th re can be little d ubt that all th m re mod rn *mari e* f rmations, namely th ppe pliocene, th pleistocen and strictly modern beds of Europe N rth and South Am rica, and Australia, from containin fossil remains in som d gree allied, and from not in luding those f rms which are f und onl in th kl und l ing depos ts, w uld be correctly ranked as simultaneous in geological sense

Th fact of th *forms of lif changin* simultaneously in th abo e lar sense t distant parts of th w rld has greatly struck these admirable obse rs, MM de V rn uil and d Archiac. Aft r ref rring to the parall li m of th palæozoic f rms of lif in various parts of Europe, they add If truck by this tran seq nce w turn our attention to N rth Am rica, and th re disco er a series of analogous phenomena, t will ppear certain that ll these modifications of pecies, th ir tinction, and the introduction of n w o es, cann t be ing to mere changes in marin curre ts o oth causes more o less local and temporary

larger naturalized quadrupeds in several parts of S America

We see in many cases in the more recent tertiary formations that rarity precedes extinction and we know that this has been the progress of events with those animals which have been exterminated either locally or wholly through man s agency I may repeat what I published in 1845 namely that to admit that species generally become rare before they become extinct—to feel no surprise at the rarity of a species and yet to marvel greatly when the species ceases to exist is much the same as to admit that sickness in the individual is the forerunner of death—to feel no surprise at sickness but when the sick man dies to wonder and to suspect that he died by some deed of violence

The theory of natural selection is grounded on the belief that each new variety and ultimately each new species is produced and maintained by having some advantage over those with which it comes into competition and the consequent extinction of the less favoured forms almost inevitably follows It is the same with our domestic productions when a new and slightly improved variety has been raised it at first supplants the less improved varieties in the same neighbourhood when much improved it is transported far and near like our short horn cattle and takes the place of other breeds in other countries Thus the appearance of new forms and the disappearance of old forms both those naturally and those artificially produced are bound together In flourishing groups the number of new specific forms which have been produced within a given time has at some periods probably been greater than the number of the old specific forms which have been exterminated but we know that species have not gone on indefinitely increasing at least during the later geological epochs so that looking to later times we may believe that the production of new forms has caused the extinction of about the same number of old forms

The competition will generally be most severe as formerly explained and illustrated by examples between the forms which are most like each other in all respects Hence the improved and modified descendants of a species will generally cause the extermination of the parent species and if many new forms have been developed from any one species the nearest allies of that species i e the species of the same genus, will be the most liable to extermination Thus, as I believe a number of new species descended from one species, that is a new genus comes to supplant an old genus belonging to the same family But it must often have happened that a new species belonging to some one group has seized on the place occupied by a species belonging to a distinct group and thus have caused its extermination If many allied forms be developed from the successful intruder many will have to yield their places and it will generally be the allied forms, which will suffer from some inherited inferiority in common But whether it be species belonging to the same or to a distinct class which have yielded their places to other modified and improved

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very difficult to account for considering the proximity of the two areas,—unless, indeed, it be assumed that an isthmus separated two seas inhabited by distinct, but contemporaneous, faunas. Lyell has made similar observations on some of the later tertiary formations. Barrande, also, shows that there is a striking general parallelism in the successive Silurian deposits of Bohemia and Scandinavia; nevertheless he finds a surprising amount of difference in the species. If the several formations in these regions have not been deposited during the same exact periods,—a formation in one region often corresponding with a blank interval in the other,—and if in both regions the species have gone on slowly changing during the accumulation of the several formations and during the long intervals of time between them; in this case the several formations in the two regions could be arranged in the same order in accordance with the general succession of the forms of life, and the order would falsely appear to be strictly parallel; nevertheless the species would not be all the same in the apparently corresponding stages in the two regions.

On the Affinities of Extinct Species to each other, and to Living Forms

Let us now look to the mutual affinities of extinct and living species. All fall into a few grand classes; and this fact is at once explained on the principle of descent. The more ancient any form is, the more, as a general rule, it

...tween them. That the extinct forms of life help to fill up the intervals between existing genera, families, and orders, is certainly true; but as this statement has often been ignored or even denied, it may be well to make some remarks on this subject, and to give some instances. If we confine our attention either to the living or to the extinct species of the same class, the series is far less perfect than if we combine both into one general system. In the writings of Professor Owen we continually meet with the expression of generalised forms, as applied to extinct animals; and in the writings of Agassiz, of prophetic or synthetic types; and these terms imply that such forms are in fact intermediate or connecting links. Another distinguished palaeontologist, M. Gaudry, has shown in the most striking manner that many of the fossil mammals discovered by him in Attica serve to break down the intervals between existing genera. Cuvier ranked the ruminants and pachyderms as two of the most distinct orders of mammals; but so many fossil links have been disentombed that Owen has had to alter the whole classification, and has placed certain pachyderms in the same sub-order with ruminants; for example, he dissolves by gradations the apparently wide interval between the pig and the camel. The Ungulata or hoofed quadrupeds are now divided into the even-toed or odd-toed divisions; but the *Macrauchenia* of S. America connects to a certain extent these two grand divisions. No one will deny that the *Hipparion* is intermediate between the existing horse and certain older ungulate forms. What a wonderful connecting link in the chain of mammals is the *Typotherium* from S. America, as the name given to it by Professor Gervais expresses, and which cannot be placed in any existing order. The Sirenia form a very distinct group of mammals, and one of the most remarkable peculiarities in the existing dugong and lamentin is the entire absence of hind limbs without even a rudiment being left; but the extinct *Halitherium* had, according to Professor Flower, an ossified thigh-bone "articulated to a well-defined acetabulum in the pelvis," and it thus makes some approach to ordinary hoofed quadrupeds, to which the Sirenia are in other respects allied. The cetaceans or whales are widely different from all other mammals, but the tertiary *Zeuglodon* and *Squalodon*, which have been placed by some naturalists in an order by themselves, are considered by Professor Huxley to be undoubtedly cetaceans, "and to constitute connecting links with the aquatic carnivora."

Even the wide interval between birds and reptiles has been shown by the naturalist just quoted to be partially bridged over in the most unexpected manner, on the one hand, by the ostrich and extinct *Archeopteryx*, and on the other hand, by the *Compsognathus*, one of the Dinosaurians—that group which includes the most gigantic of all terrestrial reptiles. Turning to the Invertebrata, Barrande asserts, a higher authority could not be named, that he is every day taught that, although palaeozoic animals can certainly be classed under existing groups, yet that at this ancient period the groups were not so distinctly separated from each other as they now are.

Some writers have objected to any extinct species, or group of species, being considered as intermediate between any two living spe-

but depend on general laws which govern the whole animal kingdom M Barrande has made forcible remarks to precisely the same effect It is, indeed quite futile to look to changes of currents climate or other physical conditions as the cause of these great mutations in the forms of life throughout the world under the most different climates We must as Barrande has remarked look to some special law We shall see this more clearly when we treat of the present distribution of organic beings and find how slight is the relation between the physical conditions of various countries and the nature of their inhabitants

This great fact of the parallel succession of the forms of life throughout the world is explicable on the theory of natural selection New species are formed by having some advantage over older forms and the forms which are already dominant or have some advantage over the other forms in their own country give birth to the greatest number of new varieties or incipient species We have distinct evidence on this head in the plants which are dominant that is which are commonest and most widely diffused producing the greatest number of new varieties It is also natural that the dominant varying and far spreading species which have already invaded to a certain extent the territories of other species should be those which would have the best chance of spreading still further and of giving rise in new countries to other new varieties and species The process of diffusion would often be very slow depending on climatal and geographical changes on strange accidents and on the gradual acclimatisation of new species to the various climates through which they might have to pass but in the course of time the dominant forms would generally succeed in spreading and would ultimately prevail The diffusion would it is probable be slower with the terrestrial inhabitants of distinct continents than with the marine inhabitants of the continuous sea We might therefore expect to find as we do find a less strict degree of parallelism in the succession of the productions of the land than with those of the sea

Thus as it seems to me the parallel and taken in a large sense simultaneous succession of the same forms of life throughout the world accords well with the principle of new species having been formed by dominant species spreading widely and varying the new species thus produced being themselves dominant, owing to their having had some advantage over their already dominant parents, as well as over other species and again spreading, varying and producing new forms. The old forms which are beaten and which yield their places to the new and victorious forms, will generally be allied in groups from inheriting some inferiority in common and therefore as new and improved groups spread throughout the world old groups disappear from the world and the succession of forms everywhere tends to correspond both in their first appearance and final disappearance

There is one other remark connected with this subject worth making I have given my reasons for believing that most of our great formations rich in fossils, were deposited during periods of subsidence and that blank intervals of vast duration as far as fossils are concerned occurred during the periods when the bed of the sea was either stationary or rising and likewise when sediment was not thrown down quickly enough to embed and preserve organic remains During these long and blank intervals I suppose that the inhabitants of each region underwent a considerable amount of modification and extinction and that there was much migration from other parts of the world As we have reason to believe that large areas are affected by the same movement it is probable that strictly contemporaneous formations have often been accumulated over very wide spaces in the same quarter of the world but we are very far from having any right to conclude that this has invariably been the case and that large areas have invariably been affected by the same movements When two formations have been deposited in two regions during nearly but not exactly the same period we should find in both from the causes explained in the foregoing paragraphs the same general succession in the forms of life but the species would not exactly correspond for there will have been a little more time in the one region than in the other for modification extinction and immigration

I suspect that cases of this nature occur in Europe Mr Prestwich in his admirable Memoirs on the eocene deposits of England and

in England with those in France although he finds in both a curious accordance in the numbers of species belonging to the same genera, yet the species themselves differ in a manner

then the families which existed at the period marked VI. would certainly have differed from ach ther by a less number of characters for the would at this earl tage f descent ha e di rged in a less d gree from th ir comm n pro nito Thus t comes that ancient and ex tinct genera are often in a greater o l ss d gree intermediate in character between th r modi fied descendants, r between th ir coll teral relations.

Under nature the process will be far more complicated than is represented in th diagram

expect, except in rare cases, t fill p th wid intervals in the natural yst m, and thus to unite distinct families rd rs. All that we ha a right to expect is, that those gro ps hich ha e, within known geol gical periods, und rgo m ch mod fication, should in th ld f rmati ns mak som slight pproach to each th so that th lder m mbers sh uld diff less from each the in some f th ir characters than d the existing members f the sam groups and thus by th co current e dence of ur best palæo tol gists is freq ntly th case

Thus, on the theory f desce t with mod fication, th main facts with respect t th m tual affinities of th tinct f rms of life to each th and to li ing f rms, are explained in satisfactory mann And th y are wholly inexplicable o any th view

which succeeded t. Th th speci wh ch li ed t th sixth great tag f desce t in th diagram are the modified offspring f those hich li ed t th fifth stage, and are th par ts of those which becam till more modified at th se th tag h nce th y could hardly fail to be nearl t rmediate charact r be t ee th f rms of lif abo and bel w W must. bo all w f th ture tinctio of som preced ng f rms, and in any regi n f th immigratio of ew forms from th regions, and f larg amo t of modification during th long and blank int rvals between th su ess f rmations. S bject to these allowances, th f una of each geological

period und ubtedly is int rmediate in character between th preceding and s cceeding f unas I need gi e nly one instance, nam ly the manne in which the foss ls f the De nian system, wh n this ystem was first disco ered w re t ce recognized by palæontol g ts as intermedi t in charact r between th se of the lyin carboniferous, and und rl in Sil rian sy t ms. B t ach fauna s n t necessarily exactly int rmed te as unequal inter als f time have elapsed b tween consecuti e formations.

It is n real objection to th truth of the tat m t th t th fauna of each period as a wh le nearly int rmediate in character between the preceding and succeeding f unas, that certain g nera ffer excepti ns t the rule. F instance the pecies of mastod ns and l phants, wh n arranged by D Falcon in tw series,—in the first place according to th ir m tual affinities, and in the second place according t th period of existe ce,—do n t accord in arrang m nt. The pec s extreme in charact r are t th oldest o the mo t recent no are those which are intermed te in char act int rmedi te in ag But supposing f an instant, in this and oth r such cases, that

h that f rms success vely prod ced necessarily ndure f *co responding lengths f time.* A ry ancient form may occas onally ha e lasted m ch l er than a form elsewhere bseq tly produced, especially in the case

d mestic p geon w re arranged in serial affinity this arrang m t w uld n t cl sely accord with th rd in tim of th ir prod ti n, and n l ss w th the rder f th disappearance f r th pare t rock p geon still li and many vari ti s b tween the rock p eon and the carri h becom tin t and carri rs which are treme in th important character f l gth f beak riginated arlier than short beaked tumbl rs, which are t th pposite end f th series in this respect.

Closely connected w th the tatem t, that th gani remains from an intermediate f rmati n are in som d gree intermediat in character is th fact, insisted n by all palæon tol gists, that f ssils from two consecuti formations are far m re closely related to each ther than are th fossils from tw remote

cies or groups of species If by this term it is meant that an extinct form is directly inter mediate in all its characters between two living forms or groups the objection is probably valid But in a natural classification many fossil species certainly stand between living species and some extinct genera between living genera, even between genera belonging to distinct families The most common case especially with respect to very distinct groups such as fish and reptiles seems to be that supposing them to be distinguished at the present day by a score of characters the an cient members are separated by a somewhat lesser number of characters so that the two groups formerly made a somewhat nearer ap proach to each other than they now lo

It is a common belief that the more ancient a form is by so much the more it tends to con nect by some of its characters groups now widely separated from each other This remark no doubt must be restricted to those groups which have undergone m r l t the diffi for

ι ο v and then even a living animal as the Lepidosiren is discovered having aff nities directed towards very distinct groups Yet if we compare the older reptiles and batra chians the older fish the older cephalopods, and the eocene mammals with the more recent members of the same classes we must a lmit that there is truth in the remark

Let us see how far these several facts and inferences accord with the theory of lescent with modification As the subject is somewhat complex I must request the reader to turn to the diagram in the fourth chapter We may suppose that the numbered letters in ital cs represent genera and the dotted lines diverging from them the species in each genus The diagram is much too simple too few genera an l too few species being given but this is un important for us The horizontal lines may represent successive geological fo n

o and j a closely allied family or ub family and o^{14} e m^{14} a third family These three families together with the many xt nct r a
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their ancient progenitor On the princi l of the continued tendency to divergence of char

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o tauy uiller from its ancient progenitor Hence we can understand the rule that the mo t ancient fossils differ most from exist ing forms We must not however assume that divergence of character is a necessary contin gency it depen ls solely on the descen lants from a species being thus enabled to seize on many and different places in the economy of nature Therefore it is quite po il le as we have seen in the case of o c ι ι

ι a u yet retain throughout a vast period the same general characteristics This is rep re sented in the diagram by the letter F^{1}

All the many form rt t t t
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By looking at the diagram e ι ι

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ι ι ι er it for instance the genera a a^{1} a^{1} f^{8} m^{3} m m were h interred these three families ι ι ι

ι as a occurr d with ruminants a l certain pachyderms Yet he who objected to consider as intermediate the extinct genera which thus link together the livi g r ι

ct t forms If many xtinct f rms w re to be discovered al o e one of th mi l lle l riz ntal lines or geolog cal form ati n —f r instance above No VI —but n ι e fron beneath this line then only two of the famil e (those on the left han l a &c and l &c) woul l have to be unit d into o e and there woul l rema n two families, which woul l b l ss di tinct from each other than th y ere before the discovery of the fo ils So again if the three families forme l of eight g nera (a^{1} to m) on the uppermost line be upposed to diff r from each other by half a-do en imp rtant characters,

and at what period the various f rms of lif first appeared and thus may w ll be disputed.

The problem wheth or~anisation on th whole has advanced is in man, w cessarely intricate The geological record, t all times imperfect, does not extend far enough back to show w th unmistakable clearness that within the known hist ry of the world organ isation has largely ad anced Ev n t th present da looking to members of the sam class, naturalists are not unanimous which forms ught t be ranked as highest thus, som look t th selaceans sharks, from their approach in some important points of structure to reptiles, as th highest fish others look at the t leost ans as th highest. Th ganoids stand intermediat between th selaceans and teleosteans. th latt t th present day are largely prepond rant in numbe but formerly selaceans and ganoid alone existed and in this case according t the standard of highness chosen, so wil t be said that fishes ha e advanced retrograded in organisation. T ttempt to compare m mbers of distinct types in th scale of highness seem hopeless who will decid wheth cuttle-fish be higher than bee—that insect which the great von Baer believed to be in fact more highl organised than fish, although upo anoth type In th comple struggle f lif t is quit cred ible that crustaceans, not very high in their wn class, might beat cephalopods, the h nest molluscs and such crustaceans, though not highly d loped, would stand ry high in the scale of in ertebrat animals, if j dged b th most decisive of all trials—th law of battle Besides these inhere t difficulties in decidin hich forms are the most ad anced in organisation, w ought not solely to compare the highest members of class at any tw periods—though undoubtedly this is one and perhaps the most important elem nt in striking a balance—b t w ought t compare all the m mbers, high and low at the two periods. At an ancient poch the hi hest and lowest molluscoidal animals, namel cephalopods and brachiopods, swarmed in numbers at the prese t time both groups are greatly reduced, hilst others, int rmediat in organisation, ha largel increased consequently some naturalists mai tain that molluscs were formerly more h l loped than at present but stronger case can be mad out on the opposite sid b considering the ast reduction of brachiopods, and the fact that our xisting cephalopods, though few in number are more highly rganised than their ancient representa t es. W ought also to compare th relati e proportional numbers at any two periods of th hi h and low classes thro ghout the wo ld if fo instance, at th present day fifty tho sand kinds of vertebrate animals exist, and if we kn w that at som form period only t n th usand kinds exis ed, w ought to look at this increase in number in the highest class, which implies a great displacement of lowe forms, as a decided ad ance in the organisation of the world. W thus see h w h pe essly diffi cult t is to compare with perfect fairness und r such extremel comple relations, th stand ards of organisation f the imperfectly kn wn f unas of successi periods.

W shall ppreciat this d fficulty more clearly b looking to certain xisting faunas and floras. From the xtraordinary mann in which European productions ha recently spread ove New Zealand, and ha seized on places which must ha been previously oc cupied by th indigenes, w must beli e that if all the animals and plants of Great Britain were set free in New Zealand, a multitude of British forms would in th course of tim be come thoroughly naturalised th re and w ld ext rminat many of th nati es. On the th hand, from th fact that hardl a sin le in hab tant f the southern hemisph re has becom wild in any part of E rope we may well doubt whether if all the productions of New Zealand were set free in Great Britain, any consid rable numbe would be enabled to seize on places now occup ed b ou nati e plants and animals. Und this point of vi w the produc tions f Great Britain stand m ch high in the scale than those of N w Zealand. Y t th most skilful naturalist, from an xamination of the species f th two countries, could not ha e f reseen this result.

Agassiz and se eral othe highly competent judge insist that anci nt animals resembl t a certain extent th mbryos of recent animals belonging to th sam classes and that th geological uccession of xtinct f rms is nearly parallel with th mbryological d elopm nt of xisting forms. This ew accords admirably w ll w th our theory In f ture chapter I shal ttempt t how that th adult di ers from ts embryo, o ing to ariations h ving supervened at not earl a and having been inherited t corresponding age This process, whilst t le ves th mbryo almost unalt red, continually adds, in th course of successi generations, more and more diff rence t th

formations Pictet gives as a well known instance the general resemblance of the organic remains from the several stages of the Chalk formation though the species are distinct in each stage This fact alone from its generality seems to have shaken Professor Pictet in his belief in the immutability of species He who is acquainted with the distribution of existing species over the globe will not attempt to account for the close resemblance of distinct species in closely consecutive formations by the physical conditions of the ancient areas having remained nearly the same Let it be remembered that the forms of life at least those inhabiting the sea, have changed almost simultaneously throughout the world and therefore under the most different climates and conditions Consider the prodigious vicissitudes of climate during the pleistocene period which includes the whole glacial epoch and note how little the specific forms of the inhabitants of the sea have been affected

On the theory of descent the full meaning of the fossil remains from closely consecutive formations being closely related though ranked as distinct species is obvious As the accumulation of each formation has often been interrupted and as long blank intervals have intervened between successive formations we ought not to expect to find as I attempted to show in the last chapter in any one or in any two formations all the intermediate varieties between the species which appeared at the commencement and close of these periods but we ought to find after intervals, very long as measured by years but only moderately long as measured geologically closely allied forms, or as they have been called by some authors representative species and these assuredly we do find We find in short, such evidence of the slow and scarcely sensible mutations of specific forms as we have the right to expect.

On the State of Development of Ancient compared with Living Forms

We have seen in the fourth chapter that the degree of differentiation and specialisation of the parts in organic beings when arrived at maturity is the best standard as yet suggested of their degree of perfection or highness We have also seen that, as the specialisation of parts is an advantage to each being so natural selection will tend to render the organisation of each being more specialised and perfect and in this sense higher not but that it may leave many creatures with simple and

unimproved structures fitted for simple conditions of life and in some cases will even degrade or simplify the organisation yet leaving such degraded beings better fitted for their new walks of life In another and more general manner new species become superior to their predecessors for they have to beat in the struggle for life all the older forms with which they come into close competition We may therefore conclude that if under a nearly similar climate the eocene inhabitants of the world could be put into competition with the existing inhabitants the former would be beaten and exterminated by the latter as would the secondary by the eocene and the palæozoic by

organs modern forms ought on the theory of natural selection to stand higher than ancient forms Is this the case? A large majority of palæontologists would answer in the affirmative and it seems that this answer must be admitted as true though difficult of proof

It is no valid objection to this conclusion that certain brachiopods have been but slightly modified from an extremely remote geological epoch and that certain land and fresh water shells have remained nearly the same from the

tions of life and what could be better fitted for this end than these lowly organised Protozoa? Such objections as the above would be nce in They amin

ifera, for instance could be proved to have first come into existence during the Laurentian epoch or the above brachiopods during the Cambrian formation for in this case there would not have been time sufficient for the development of these organisms up to the standard which they had then reached When advanced up to any given point, there is no

in the ca es of Brazil, th re are many extinct species which are losel all ed in size and in all other charact rs to th species still livin, in South America and som f these fossil may have been th actual pro nitors f th l vin pecies. It mu t not be f rg tten that, ur theory all th pecies of the same ge us are the descendants of som e species so th t, if six gen ra, each ha in ight pecies, be found in one geolo ical f rmation, and in a succeeding f rmation th re be six the al ed or representati g era each with th sam umber of pecies, the w ma co lud that general onl pecies of each f th ld r genera has left modified descendants, which constitute the n w g nera co taining th se eral species the ther se n species of each ld genus having d ed t and l ft no progen O and this will be far commone case two o three species in two or three alo of th ix older genera will be th parents of th n w genera th th pecies and th oth ld genera having become tt rl extinct. In failing orders, w th the n ra and pecies decreasing in umbers as is th case with the Edentata of South Am rica, still few genera and species will lea modified blood-descend ants.

S mmary of the p ced ng and p sent Chapters

I ha ttempted t sh w that th geolo ical record is trem l imperfect that nly a small portion of th globe has been geologically explored w th care that nly certain classes of organic beings ha bee larg l preserved in fossil tat that the numbe both of speci mens and of species, preserved in our museums, is absol t l as nothi compared w th th umbe of g nerations which must ha passed y en during single formatio that, wing to subsidence bei g almost necessary for the accumulation of d posits rich in fossil pecies of man kinds, and thick nough to outlast f ture d gradation, great int rvals of time must ha lapsed between most of ur successi formations that there has probably been more tinction durin the periods of subsidence and more ariation during th period of le ation, and during the latt th record will ha been less perfectl kept that each single formation has not been continuousl deposited that the duration of each f rmation is probabl short compared with th rage duration of pecific forms that migratio has played an important part in the first appear ance of n w forms in any on area and f rmation th t wid ly rangin species are those which ha varied most frequ ntly and ha e oftenest gi n rise t n w pecies th t are-t es ha e t first been local and lastly althou h ach species mu t ha passed through n m ous transiti nal ta s, t is probable that th periods durin which ach underwent mod fi cation, th u h many and lon as measured by years, ha been sh rt in comparison w th th periods durin which each remained in an unchan ed condition. These causes, tak n con jointl will to a lar xtent explain wh — though we d find many links—w do n t find interminabl ari ties, connecting to eth all extinct and existing f rms by th finest grad ated st ps. It should also be constantly born in mind that any linkin ari ty between two f rms, which might be found, would be ranked unless th wh l chain could be perfectly re st red as n w and distin t pecies f t is n t pret nded that w ha any sure crit rion by which species and vari ties can be discrim inated.

H who rejects this view f th imperfection of th geolo ical record will rightly reject th whol theory F he may a k in vain wh re are the numberless transitional links which must f rmerly ha e connected th closely allied representat e species, found in th successi ta es of th sam great f rmation H ma disbelie in th immense interval of tim which must hav elapsed between our consecuti f rmations h may overlook how important a part migration has played wh n th f rmations of an great regi n, as those of Europe are consid red h ma urg tl pparent, b t often falsely pparent, sudd n coming in of whol gro p f pecies. H may ask wh re are th remains f those infinit ly num rous organisms which must hav xisted lo g bef re th Cambrian system was deposited W now kn w th t t least o animal did then xist b t I can answ this last question nly by supposing that where ur oceans now extend th ha e extended for an no mous period, and wh re our oscillating co tinents now stand th ha stood since th commencement f the Cambrian system but that, long bef re that poch, th w rld pre se ted a wid l diff rent a pect and that th ld co tin ts f rmed of formations ld than any known t us, xist now nly as remnants in m tam rphosed condition, h still buried und th ocean.

Passing from these difficulties, th oth r

adult Thus the embryo comes to be left as a sort of picture preserved by nature, of the former and less modified con lition of the spe cies This view may be true and yet may never be capable of proof Seeing for instance that the oldest known mammals reptiles and fishes strictly belong to their proper classes, though some of these old forms are in a slight degree less distinct from each other than are the typical members of the same groups at tl present d

ar beneath the lowest Cam brian strata—a discovery of which the chance is small

On the Succession of the same Types within the same Areas during the later Tertiary periods

Mr Clift many years ago showed that the fos il mammals from the Australian caves were closely allied to the living marsupials of that continent In South America a similar rela tionship is manifest even to an uneducated eye in the gigantic pieces of armour like those of the armadillo foun l in several parts of La Plata and Professor Owen has sl own in the most striking manner that most of the fossil mammals buried there in such numbers are related to South American types This rela tionship is even more clearly seen in the won derful collection of fos il bones made by MM Lund and Clausen in tl e caves of Brazil I was so much impres e l with these facts that I strongly insiste l in 1839 and 184 on this law of the succession of types —on this wonderful relationship in the same continent between the dead an l the living Professor Owen has sub equently extended the same generalisation to the mammals of the Ol l World We see the same l n tl

t same law holds good with sea sl ells but from the wide di tribution of most molluscs it is not well di played by tl m O l ases e ex and g brackish water shells of the Aralo-Ca p an Sea.

Now what does tl is remarkable law of the succession of the same types witl in the same areas mean? He would be a bold man who after comparing the pre ent climate of Aus tralia an l of parts of South America, under the same latitude woul l attempt to account, on the one hand through dissimilar physical con ditions, for the dissimilarity of the inhabitants of these two continents and on the other hand through similarity of conditions, for the uni formity of the same types in each continent during the later tertiary periods. Nor can it be pretended that it is an immutable law that marsupials should have been chiefly or solely produced in Australia or that Edentata and other American types sl o ll

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was formerly different from what it now is North America formerly partook strongly of the present character of the soutl ern half of the continent an l the southern half was for merly more closely allied than it is at present to the northern half In a similar manner we know from Falconer an l Cautley s discoveries, that Northern India was formerly more closely related in its mammals to Africa than it is at the present time Analogous facts could be given in relation to the di tribution of marine animals

On the theory of descent with modification, the great law of the long enduring but not immutable succession of the same types witl in the same areas is at once explained for the inhabitants of each quarter of the worl l will obviously ten l to leave in that quarter durin the next ucceeding period of time closely allied though in some degree modified de scen lants If the inhabitants of one continent formerly differed greatly from those of anotl er continent, so will their modified descen lants still differ in nearly the same manner an l de gree But after very long in tervals of time and after great geographical changes permitting much intermigration the feebl r will yiel l to the more dominant forms, and there will be nothing immutable in the distribution of or ganic beings

It may l e asked in ri licule whether I sup pose that the *Megatherı ı* an l other all ed huge monsters, wl ch formerly lived in South America, have left behin l them the sl tl armadillo an l anteater as tl eir legenerate d scen lant This cannot for an instant be admitted Tl ese l uge animals have become wholly extinct and l ave left no progeny But

CHAPTER XII

GEOGRAPHICAL DISTRIBUTION

In considering the distribution of organic beings over the face of the globe, the first great fact which strikes us is, that neither the similarity nor the dissimilarity of the inhabitants of various regions can be wholly accounted for by climatal and other physical conditions. Of late, almost every author who has studied the subject has come to this conclusion. The case of America alone would almost suffice to prove its truth; for if we exclude the arctic and northern temperate parts, all authors agree that one of the most fundamental divisions in geographical distribution is that between the New and Old Worlds; yet if we travel over the vast American continent, from the central parts of the United States to its extreme southern point, we meet with the most diversified conditions; humid districts, arid deserts, lofty mountains, grassy plains, forests, marshes, lakes, and great rivers, under almost every temperature. There is hardly a climate or condition in the Old World which cannot be paralleled in the New—at least as closely as the same species generally require. No doubt small areas can be pointed out in the Old World hotter than any in the New World; but these are not inhabited by a fauna different from that of the surrounding districts; for it is rare to find a group of organisms confined to a small area, of which the conditions are peculiar in only a slight degree. Notwithstanding this general parallelism in the conditions of the Old and New Worlds, how widely different are their living productions!

In the southern hemisphere, if we compare large tracts of land in Australia, South Africa, and western South America, between latitudes 25° and 35°, we shall find parts extremely similar in all their conditions, yet it would not be possible to point out three faunas and floras more utterly dissimilar. Or, again, we may compare the productions of South America south of lat. 35° with those north of 25°, which consequently are separated by a space of ten degrees of latitude, and are exposed to considerably different conditions; yet they are incomparably more closely related to each other than they are to the productions of Australia or Africa under nearly the same climate. Analogous facts could be given with respect to the inhabitants of the sea.

A second great fact which strikes us in our general review is, that barriers of any kind, or obstacles to free migration, are related in a close and important manner to the differences between the productions of various regions. We see this in the great difference in nearly all the terrestrial productions of the New and Old Worlds, excepting in the northern parts, where the land almost joins, and where, under a slightly different climate, there might have been free migration for the northern temperate forms, as there now is for the strictly arctic productions. We see the same fact in the great difference between the inhabitants of Australia, Africa, and South America under the same latitude; for these countries are almost as much isolated from each other as is possible. On each continent, also, we see the same fact; for on the opposite sides of lofty and continuous mountain-ranges, of great deserts and even of large rivers, we find different productions; though as mountain-chains, deserts, &c., are not as impassable, or likely to have endured so long as the oceans separating continents, the differences are very inferior in degree to those characteristic of distinct continents.

Turning to the sea, we find the same law

Echinodermata in common, but Dr. Gunther has recently shown that about thirty per cent. of the fishes are the same on the opposite sides of the isthmus of Panama; and this fact has led naturalists to believe that the isthmus was formerly open. Westward of the shores of America, a wide space of open ocean extends, with not an island as a halting place for emigrants; here we have a barrier of another kind, and as soon as this is passed we meet in the eastern islands of the Pacific with another and totally distinct fauna. So that three marine faunas range far northward and southward in parallel lines not far from each other, under corresponding climates; but from being separated from each other by impassable barriers, either of land or open sea, they are almost wholly distinct. On the other hand, proceeding still farther westward from the eastern islands of the tropical parts of the Pacific, we en

great leading facts in palæontology agree admirably with the theory of descent with modification through variation and natural selection We can thus understand how it is that new species come in slowly and successively how species of different classes do not necessarily change together or at the same rate or in the same degree yet in the long run that all undergo modification to some extent The extinction of old forms is the almost inevitable consequence of the productions of new forms We can understand why when a species has once disappeared it never reappears Groups of species increase in numbers slowly and

dominant species belonging to large and dominant groups tend to leave many modified descendants which form new sub groups and groups As these are formed the species of the less vigorous groups from their inferiority in

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sometimes been a slow process from the survival of a few descendants lingering in protected and isolated situations When a group has once wholly disappeared it does not reappear for the link of generation has been broken

We can understand how it is that dominant forms which spread widely and yield the greatest number of varieties tend to people the world with allied but modified descendants and these will generally succeed in displacing the groups which are their inferiors in the struggle for existence Hence after long intervals of time the productions of the world appear to have changed simultaneously

We can understand how it is that all the forms of life ancient and recent make together a few grand classes We can understand from the continued tendency to divergence of character why the more ancient a form is the more it generally differs from those now living why ancient and extinct forms often tend to fill up gaps between existing forms sometimes blending two groups, previously classed as distinct into one but more commonly bringing them only a little closer together The more ancient a form is the more often it stands in some degree intermediate between groups now distinct for the more ancient a form is, the more nearly it will be related to and consequently resemble the common progenitor of groups since become widely divergent. Extinct forms are seldom directly intermediate between existing forms but are intermediate only by a long and circuitous course through other extinct and different forms We can clearly see why the organic remains of closely consecutive formations are closely allied for they are closely linked together by generation We can clearly see why the remains of an intermediate formation are intermediate in character

far higher in the scale and their structure has generally become more specialised and this may account for the common belief held by so many palæontologists that organisation on the whole has progressed Extinct and ancient animals resemble to a certain extent the embryos of the more recent animals belonging to the same classes and this wonderful fact receives a simple explanation according to our views The succession of the same types of structure within the same areas during the later geological periods ceases to be mysterious and is intelligible on the principle of inheritance

If then the geological record be as imperfect as many believe and it may at least be asserted that the record cannot be proved to be much more perfect the main objections to the theory of natural selection are greatly diminished or d ... On the other hand all the chief

supplanted by new and improved forms life the products of Variation and the Survival of the Fittest.

CHAPTER XII

GEOGRAPHICAL DISTRIBUTION

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We can thus understand how it is that new species come in slowly and successively how species of different classes do not necessarily change together or at the same rate or in the same degree yet in the long run that all undergo modification to some extent The extinction of old forms is the almost inevitable consequence of the productions of new forms We can understand why when a species has once disappeared it never reappears Groups of species increase in numbers slowly and endure for unequal periods of time for the process of modification is necessarily slow and depends on many complex contingencies The dominant species belonging to large and dominant groups tend to leave many modified descendants which form new sub groups and groups As these are formed the species of the less vigorous groups from their inferiority inherited from a common progenitor tend to become extinct together and to leave no modified offspring on the face of the earth But the utter extinction of a whole group of species has sometimes been a slow process from the survival of a few descendants lingering in protected and isolated situations When a group has once wholly disappeared it does not reappear for the link of generation has been broken

We can understand how it is that dominant forms which spread widely and yield the greatest number of varieties tend to people the world with allied but modified descendants and these will generally succeed in displacing the groups which are their inferiors in the struggle for existence Hence after long intervals of time the productions of the world appear to have changed simultaneously

We can understand how it is that all the forms of life ancient and recent make together a few grand classes We can understand from the continued tendency to divergence of character why the more ancient a form is the more it generally differs from those now living why ancient and extinct forms often tend to fill up gaps between existing forms sometimes blending two groups, previously classed as distinct into one but more commonly bringing them only a little closer together The more ancient a form is the more often it stands in some degree intermediate between groups now distinct for the more ancient a form is, the more nearly it will be related to and consequently resemble the common progenitor of groups since become widely divergent Extinct forms are seldom directly intermediate between existing forms but are intermediate only by a long and circuitous course through other extinct and different forms We can clearly see why the organic remains of closely consecutive formations are closely allied for they are closely linked together by generation We can clearly see why the remains of an intermediate formation are intermediate in character

The inhabitants of the world at each successive period in its history have beaten their predecessors in the race for life and are in so far higher in the scale and their structure has generally become more specialised and this may account for the common belief held by so many palæontologists that organisation on the whole has progressed Extinct and ancient animals resemble to a certain extent the embryos of the more recent animals belonging to the same classes and this wonderful fact receives a simple explanation according to our views The succession of the same types of structure within the same areas during the later geological periods ceases to be mysterious and is intelligible on the principle of inheritance

more perfect, the main objections to the theory of natural selection are greatly diminished or disappear On the other hand all the chief

supplanted by new and improved forms of life the products of Variation and the Survival of the Fittest.

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Accord to tl se ws, t b ou that th se ral pec es f tl san g n s, tl o gl nhab ting tl mo t d tant q art rs f the w ld must rg all l proceeded from th sam source as th re d scended from th sam pro nit I tl case f th se pe cies hich h un l rg d tl wh le geolo cal pe od l ttl odific t n, th re is not m ch d ffi lt bel g th t th l migr ted from th sam reg f d ng tl ast geogr ph l and l m tal cl ang l icl ha pers ed ce an t t m s, lm t an am t f m gration is pos bl B t many th cases, wh cl h reaso t bel tl t th pecies f g l bee prod ced th comparati ly rece t t m s, th re gre t d ffi lt n this h ad It is also b ious th t th d nd als f th sam pe ci s, th gh w inhab ting distant and iso lated regi ns, must h proceeded from pot, wh re th pare ts re first p od ced f as has bee plamed t red bl tl t d id al d t call th sam sl ld h bee p od ced from pare ts pecifi ally dis ti t

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ibl h m grated from som po t t th se ral d t t d sol ted po ts, wl w f d \ tl l tl m l t f tl w tl t acl pec was first prod ced th singl re capt t tl m nd H wh reject t reject tl f rd nary g rat th s l seq t m grat n, and calls tl g f m l It sall adm tted tl t m t case tl are in h t ted l pec es o tin and th t h pla t mal nhal t t po t so d tant f m acl tl w th an t rval f cl nat re tl t tl pace co ld t l bee eas l passed b m gratio th fact is g as som tl ng markabl and cep tional. Th incapacity f migratin across a

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sam so th t a m lt t l f European an mal and plants l beco nat ral zed n A ca and Aust alia nd so e f th abori nal plants are d t lly tl sa n at these d t nt points f th n tl rn ar l so thern l em pl res. Tl an as I bel e, s, tl t mamm l l t been al le to m grat wl reas som pla ts, fr m tl r aried m f d persal l e m rated across the w l l brok t r spaces. Th gre t and trik g fl nce f barri rs of all k nds, t ll gibl le ly n tl ew tl t th gre t maj rit of peci ha bee prod ce l l l h t bee abl to m g t t tl p sit de So f fam l s, v sub f l es, ry n y g a, ar l t ll gre t r be f sect ns f g a, re co fi ed to a gl re io ar l t l as bee bserved by se ral t alist tl t tl ost t ral g n ra, tl ose ge ra in wl cl tl pec are m t closel rel ted t acl otl are g rally co fi ed t tl sam o try f they l e d ang that tl an is co t s. What tra g mal t w ld be, f l rectly pposit r le w re t pre l, wl w g d w t j lo th series, nan l to tl ind d als f tl sam pec s, and th se had not been, t least at first, conf ed to som regi

H ce t seems t m as t l as to nan th nat al ts, tl t th w of ach pec s l ving been prod ced area k and ha bseq tl m grated from that re as far as ts po rs f m ration and b sist ce nd pa t and prese t cond t perm tted tl t probabl t ndo l tedl m cases occ wl h w cann t plain h th sam pec es co ld l passed from point t th tl B t tl geogra l ical and l m tal l g wl cl ha ce ta l occurred w tl rece t geological t mes, t h d red d sco t th f m l co t ang f man pecies. So th t w re red ced t con d wh ther th ceptions to

counter no impassable barriers and we have innumerable islands as halting places or continuous coasts until after travelling over a hemisphere we come to the shores of Africa and over this vast pace we meet with no well defined and distinct marine fauna Although so few marine animals are common to the above named three approximate faunas of eastern and western America and the eastern Pacific islands yet many fishes range from the Pacific into the Indian Ocean and many shells are common to the eastern [illegible] he I [illegible] almost

t ura great fact partly include l in the foregoing statement is the affinity of the production of the same continent or of the same sea tl ough the species themselve n [illegible]

ura ist in travelling for instance from north to south never fails to be struck by the manner in which successive groups of being specifically distinct though nearly related replace each other He hears from clo ely allied yet distinct kinds of bir ls notes nearly similar an l sees their nests similarly constructed but not quite alike with eggs coloured in nearly the same manner The plains near the Straits of Magellan are inhabited by one p cies of Rhea (American ostrich) and northward the plains of La Plata by anotl er pecies of the same genus and not by a true ostrich or emu like those inl al iting Africa an l Australia under the same latitu le On these same pl ins of La Plata we see the agouti an l bizcacha animals having nearly the same habits as our hares and rabbits and l elonging to th same order of rodents but they plainly di play an American type of tructure We ascen l th lofty peaks of the Cordillera and ve f d an alp ne species of bizcacha we look to the water and we do not find the beaver or mu k rat but the coypu and capybara rodents of tl e S American type Innumer ble oth r in tances could be given If we look to the i lands off the American sl ore however much they may differ in geological tructure the inhabitants are essentially American though they may l e all peculiar pecies. We may look back to past ages, as shown in the last chapter an l we fin l American types then prevailing n the American continent and in tl e American sea W see in these facts some leep organic l on l throughout pace and time over the ame

[illegible]

The bond is simply inheritance that ca e which alone as far as we positively know produces organisms quite like each other or as we see in the case of varieties nearly alike The dis imilarity of the inhabitants of d fferent regions may be attributed to modification through variation an l natural selec[illegible] nd

i gration of the more dominant forms of life from one region into another having been more or less effectually prevented at periods m re or less remote —on the nature an l number of the former immigrants —an l on the acti n of the inhabitants on each otl er in lea li g to tl

the most important of all relation Thus the high importance of barriers comes into play by checking migration as does time for tl e low process of modification tl rough natural selection Wi lely ranging specie ab unding in in lividual which have alrea ly triumphed over many competitors in their ov n widely extended l omes will have the best chance of seizing on n w pla e when they prea l nto new countrie In tl eir ne v homes tl ey will be expo e l t nev conditions and will frequently un lergo furtl er m xlification an l improvement an l thus tl ey will become still furtl er vict rion and v ill pr xl ice groups of modif [illegible] de c n lant. On this principle of inheritance with modification v e can un lerstan l h w it is tl at sections of gen ra v l ole genera, an l ev n families are onfine l to the same areas, as is so commonly and notoriously the case

There is no evi lence as v as r mark d in th la t chap te of tl e exi tence of any la [illegible] i c ary levelop n ent A th variability f each pec s is an n lepen ler t property and will l e tak n a lvant [illegible]

to m quantity If a numl er of pec alt r l av ng lo ig competed v ith each otl r in tl e r ol l h me wer to migrate in a l ody int a n w an l ft rwards isolat l co intry they w ul l be little li l le to modificati n for ne tl r migration no isolation in th msel s effect anything These princ ples com into play only by

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continuity of range are so numerous and of so grave a nature that we ought to give up the belief rendered probable by general considerations that each species has been produced within one area and has migrated thence as far as it could It would be hopelessly tedious to discuss all the exceptional cases of the same species now living at distant and separated points nor do I for a moment pretend that any explanation could be offered of many instances But after some preliminary remarks I will discuss a few of the most striking classes of facts namely the existence of the same species on the summits of distant mountain ranges and at distant points in the arctic and antarctic regions and secondly (in the following chapter) the wide distribution of freshwater productions and thirdly the occurrence of the same terrestrial species on islands and on the nearest mainland though separated by hundreds of miles of open sea If the existence of the same species at distant and isolated points of the earth s surface can in many instances be explained on the view of each species having migrated from a single birthplace then considering our ignorance with respect to former climatal and geographical changes and to the various occasional means of transport the belief that a single birthplace is the law seems to me incomparably the safest

In discussing this subject we shall be enabled at the same time to consider a point equally important for us namely whether the several species of a genus which must on our theory all be descended from a common progenitor can have migrated undergoing modification during their migration from some one area If when most of the species inhabiting one region are different from those of another region though closely allied to them it can be shown that migration from the one region to the other has probably occurred at some former period our general view will be much strengthened for the explanation is obvious on the principle of descent with modification A volcanic island for instance upheaved and formed at the distance of a few hundreds of miles from a continent would probably receive from it in the course of time a few colonists, and their descendants though modified would still be related by inheritance to the inhabitants of that continent Cases of this nature are common and are as we shall hereafter see inexplicable on the theory of independent creation This view of the relation of the species of one region to those of another does not differ much from that advanced by Mr Wallace who concludes that every species has come into existence coincident both in space and time with a pre existing closely allied species And it is now well known that he attributes this coincidence to descent with modification

The question of single or multiple centres of creation differs from another though allied question —namely whether all the individuals of the same species are descended from a single pair or single hermaphrodite or whether as some authors suppose from many individuals simultaneously created With organic beings which never intercross if such exist each species must be descended from a succession of modified varieties that have supplanted each other but have never blended with other individuals or varieties of the same species so that at each successive stage of modification all the individuals of the same form will be descended from a single parent But in the great majority of cases namely with all organisms which habitually unite for each birth or which occasionally intercross the individuals of the same species inhabiting the same area will be kept nearly uniform by intercrossing so that many individuals will go on simultaneously changing and the whole amount of modification at each stage will not be due to descent

difference and superiority to descent from any single pair but to continued care in the selecting and training of many individuals during

centres of creation I must say a few words on the means of dispersal

Means of Dispersal

Sir C Lyell and other authors have ably treated this subject I can give here only the briefest abstract of the more important facts. Change of climate must have had a powerful influence on migration A region now impassable to certain organisms from the nature of its climate might have been a high road for migration when the climate was different I shall however presently have to discuss this branch of the subject in some detail Changes of level in the land must also have been highly influential a narrow isthmus now separates

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f aff ty between tl mammals inl ab ting ılands w th those of tl e n are t co ti ent b g u part d t rm ned (as we sh ll l ereaft r see) by t l ı tl of tl t rven ng ocean — these and tl er cl fact are pposed to th ad ss of h prod gı s geog ph cal ı w tl tl rece t period as are

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d nce f gre t oscıll t n tl l l f tl land se b t t f l ast l g tl pos t l t n. f co tin ts, as t ha ted tl m w tl tl rece t pe od to ach th d to tl se al t g

f plants and f ma an mals d ring th mıgr t I tl co al-p od ocean h nk ıslands are w m ked b rı gs f coral t ll t d g th m Wh t f lly admitted as t w ll som d \ be that ach pec has proceeded f m gl l th place and wl n th co se f tım w k som tl g d fi t bo t tl f d tr b tıo hall b nabled t pec l t w tl security th f m t f tl la d B t I d t b l th t t will be pro ed tl t w th th ece t pe od m t f co tı ts h ch w ta d q t sepa t h bee co tın sly lm t co t ly mted with ach th and w th th m y xist g ocean sland Se ral facts d s- t b t — cl as tl gre t l ff th mar f as tl pp t des f almost rı co t t —th l se rel t n f tl t rtiary ıl ab tar t f se al land an l seas t tl p sı t nl b t ts,—tl d gree

I bota cal ks, tl ıs tl t pla t ıs oft n t ted to be ll ad ı t lf l l se nat b t th gre t l fac l t f r tran po t ross tl sea m be sa d to be alm t w l lly kr w l t l l tried w th Mr B k l y s d f peri ts, t was t e n known l w f seed co ld resı t th ıuri action of sı w t *T n ıı nse l l und tl t ut* l 87 kinds, 64 g m t l aft r an ımm rsion f 28 d s, an l f w su ed an m rs n f 13 d ys. It d serve t ce tl t ce ta n nl rs w far m re ı red tl otl rs m e Le- g m sı w re tr ed and w tl cept tl y re ısted th salt w t l adly se en pe f th all ed rd s, H droph llaceæ nd P l m aceæ w re all killed by a m th s m rs F r co em ce sake I cl fl tried mall seed tl t tl p le fr t l as all f th se sa k f w d tl old t h be n fl ted acros w l pa f tl a, wl tl t tl \ ıured by th salt t Aft rd I t ed so l fru ts, p les, &c. and som f tl se fl ated f al g t m It ı ll k wn wl t a l lf

b ches f 94 ı l t w th pe f t, nd to

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place them on sea water The majority sank rapidly but some which whilst green floated for a short time when dried floated much longer for instance ripe hazel nuts sank immediately but when dried they floated for 90 days and afterwards when planted germinated an asparagus plant with ripe berries floated for 23 days when dried it floated for 85 days and the seeds afterwards germinated the ripe seeds of *Helosciadium* sank in two days when dried they floated for above 90 days and afterwards germinated Altogether out of the 94 dried plants 18 floated for above 28 days and some of the 18 floated for a very much longer period So that as $\frac{64}{87}$ kinds of seeds germinated after an 3

. . . . after being dried for above 28 days, we may conclude as far as anything can be inferred from these scanty facts that the seeds of $\frac{14}{100}$ kinds of plants of any country might be floated by sea currents during 28 days and would retain their power of germination In Johnston's *Physical Atlas* the average rate of the several Atlantic currents is 33 miles per diem (se . . . ts run . . . on this . . . ing to . . . miles . . . to another country and when stranded if blown by an inland gale to a favourable spot would germinate

Subsequently to my experiments M Martens tried similar on . . . but in a much better manner for he placed the seeds in a box in the actual sea so that they were alternately wet and exposed to the air like really floating plants He tried 98 seeds mostly different from mine but he chose many large fruits and likewise seeds from plants which live near the sea and this would have favoured both the average length of their flotation and their resistance to the injurious action of the salt water On the other hand he did not previously dry the plants or branches with the fruit and this as we have seen would have caused some of them to have floated much longer The result was that $\frac{18}{98}$ of his seeds of different kinds floated for 4 . days, and were then capable of germination But I do not doubt that plants exposed to the waves would float for a less time than those protected from violent movement as in our experiments. Therefore it would perhaps be safer to assume that the seeds of about $\frac{10}{100}$ plants of a flora, after having been dried could be floated across a space of sea 900 miles in width and would then germinate The fact of the larger fruits often floating longer than the small is interesting as plants with large seeds or fruit which as Alph de Candolle has shown generally have restricted ranges, could hardly be transported by any other means.

Seeds may be occasionally transported in another manner Drift timber is thrown up on most islands even on those in the midst of the widest oceans and the natives of the coral islands in the Pacific procure stones for their tools, solely from the roots of drifted trees these stones being a valuable royal tax I find that when irregularly shaped stones are embedded in the roots of trees, small parcels of earth are frequently enclosed in their interstices and behind them — so perfectly that not a particle could be washed away during the longest transport out of one small portion of earth thus *completely* enclosed by the roots of an oak about 50 years old three dicotyledonous plants germinated I am certain of the accuracy of this observation . . . I

. . . at many kind . . .

f . . . immersion in sea water but some taken out of the crop of a pigeon which had floated on artificial sea water for 30 days, to my surprise nearly all germinated

Living birds can hardly fail to be highly effective agents in the t . . . tion of seeds . . . frequently . . . gale to vast . . . We may safely assume that under such circumstances their rate of flight would often be 35 miles an hour and some authors have given a far higher estimate I have never seen an instance of nutritious seeds passing through the intestines of a bird but hard seeds of fruit pass uninjured through even the . . . organs of a turkey In the course of two months I . . . in my garden 12 kinds of seeds . . . of small birds and these . . . perfect and some of them . . . tried germinated But the following fact is more important the crops of birds do not secrete . . .

. . . I can positively assert that all the grains do not pass into the gizzard for . . . or even eighteen

hours. A bird in this int rval m ght easily be blown to the distance f ,00 miles, and hawks are known t look t for tired b rds, and tl contents of their t rn rops m ght thus readily get scatt red. Som h wks and wls bo t th pre whole and, afte an t rv l f from twel to tw ty hours, d rge pell ts, wh h, as I know from xperime ts mad n th Zoological Gardens, incl d seeds capabl f g rmination. Some seed of th oat, wh at, millet, canary h mp, l and beet g rminated after ha ing been from tw l t t ent ne hours in th t mach of d ff re t b rd of prey and two seed of beet grew aft h g bee th retained f t d s and f teen hours. Fresh-w ter fish, I fi d, t seed of man land and w ter plants fish are fre q tl dev red b b rds, and th th seed m ght be transported from place to place I f rced man kinds f seed t th tomachs of dead fish, and th g th ir bod to fish eagles, t ks, and pelicans these b rds, afte an int rval f man h rs, th rejected th seeds in pell ts passed th m th ir crement and se ral of these seed retai ed th pow f g rm nation. C rtai seeds, l w w re alw killed b this process.

Locusts are som times bl wn t great distances from the land I m self ca ght n 3 0 miles from th coast f Africa, and ha heard of th rs ca g t t gre t d tances. Th Re R. T Low inf rmed r C L ll that November 1844 warm of locusts isited th land f Madeira. Th w re co tless umbers, as thick as th flakes f now in th heaviest nowstorm, and t nded pwards as far as could be see w th t lescope During tw three d th l wly careered ro d and round in an imm nse llipse t lea t fi si miles in diam t and t n ht alighted th tall trees, which were complet ly coated with them Th th disappeared th sea, as dd nl as th had ppeared, and ha not ce sited th land. N w in parts f N tal t beli ed b som farm rs, th gh ins ffici t dence th t inj rious seeds are introd ced into th ir grass-land th dun left b th gre t flights f locust which often t th t country I conseq nce of this belief M Weale se t m in lett mall pack t f th dried pell ts, t f which I tracted nder th microscope se eral seeds, and raised from th m se grass plants, belo ging t tw pecies, of tw g era. Hence warm of locu ts, uch as that which isited Madeira, might read l be th means of introd ci se ral kinds of plants into an island l ng far from th mai land.

Alth ough the beaks and feet of birds are ge rally cl an, arth sometimes adh res to th m o e case I remo ed sixty-one grains, and n anoth r case tw nty two grains of dry argillaceo arth from th foot of a partridg and n the earth there was a pebble as lar as tl seed of tch. H re is a bette case tl l of a woodcock was sent to me by a fri nd, with a littl cak of dry earth attached to the hank, weigh ng l nin grains and this co tai ed a seed of th toad rush (*Juncus b fonius*) which g rm nated and flowered M S sland f Bri t who d ri g tl last f rt ars has paid close attentio to o m grat ry birds, inf rm me that I ha oft n h t wagtails (M tacillæ) wh at-ears, and whinchats (axicolæ) on their first arri al n o h res, bef re th y had al ghted nd he has se eral times noticed little cakes of arth ttached to tl r feet. Man facts co ld be gi howing h w generally so l is charged w h seed F r nstance Prof Newt n sent

... and w hing si and a half ounces. Th arth had bee k pt fo three ars, b t wh n brok n, w t red and placed nd a bell glass, less than 8 plants pru g from t these con isted f l m nocot led ns, including the common oat, and t lea t ne kind of grass, and of 0 dicot led ns, which consisted, j dging from th g l s, of t least three distinct pecies. W th uch facts bef re us, can w d ubt th t th man b rd which are annuall blown b gal across great spaces of ocean, and which ann all migrat —f instance th millions of q ails across the Medit rran an— m t occasionall transport a f w seeds m bedded in dirt adh n to th ir feet or beaks B t I hall h to recur to this subject.

As *icebergs are known to be* som times loaded with rth and stones, and ha e n arried brushwood, bones, and th nest of a land b rd t can hardl be doubted that th y m t occasionall as ggested by Ly ll, ha tran ported seed from o part to anoth f th arctic and antarctic regions and durin th Glacial period from o part f the n w t mperat regions t anoth In th Azores, from th lar mbe f plants commo to E rope in compariso w th th species n th other islands of th Atlantic, wh h tand n arer to th *mainland* and (as remarked by

Mr H C Watson) from their somewhat northern character in comparison with the *latitude I suspected that these islands had* been partly stocked by ice borne seeds during the Glacial epoch At my request Sir C Lyell wrote to M Hartung to inquire whether he had observed erratic boulders on these islands and he answered that he had found large fragments of granite and other rocks which do not occur in the archipelago Hence we may safely infer that icebergs formerly landed their rocky burthens on the shores of these mid ocean islands and it is at least possible that they may have brought thither some few seeds of northern plants

Considering that these several means of transport and that other means which without doubt remain to be discovered have been in action year after year for tens of thousands of years it would I think be a marvellous fact if many plants had not thus become widely transported These means of transport are sometimes called accidental but this is not strictly correct the currents of the sea are not accidental nor is the direction of prevalent gales of wind It should be observed that scarcely any means of transport would carry seeds for very great distances for seeds do not retain their vitality when exposed for a great length *of time to the action of sea water nor could* they be long carried in the crops or intestines of birds These means however would suffice for occasional transport across tracts of sea some hundred miles in breadth or from island to island or from a continent to a neighbouring island but not from one distant continent to another The floras of distant continents would not by such means become mingled but would remain as distinct as they now are The currents, from their course would never bring seeds from North America to Britain though they might and do bring seeds from the West Indies to our western shores where if not killed by *their very long immersion in salt* water they could not endure our climate Almost every year one or two land birds are blown across the whole Atlantic Ocean from North America to the western shores of Ireland and England but seeds could be transported by these rare wanderers only by one means, namely by dirt adhering to their feet or beaks, which is in itself a rare accident. Even in this case how small would be the chance of a seed falling on favourable soil and coming to maturity! But it would be a great error to argue that because a well stocked island like Great Britain has not as far as is known (and it would be very difficult to prove this) received within the last few centuries, through occasional means of transport, immigrants from Europe or any other continent, that a poorly stocked island though standing more remote from the mainland would not receive colonists by similar means. Out of a hundred kinds of seeds or animals transported to an island even if far less well stocked than Britain perhaps not more than one would be so well fitted to its new home as to become naturalised But this is no valid argument against what would be effected by occasional means of transport during the long lapse of geological time whilst the island was being upheaved and before it had become fully stocked with inhabitants On almost bare land with few or no destructive insects or birds living there nearly every seed which chanced to arrive if fitted for the climate would germinate and survive

Dispersal during the Glacial Period

The identity of many plants and animals, on mountain summits separated from each other by hundreds of miles of lowlands where Alpine species could not possibly exist is one of the most striking cases known of the same species *living at distant points without the apparent* possibility of their having migrated from one point to the other It is indeed a remarkable fact to see so many plants of the same species living on the snowy regions of the Alps or Pyre-

States of America, are all the same with those of Labrador and nearly all the same as we hear from Asa Gray with those on the loftiest mountains of Europe Even as long ago as 1747 such facts led Gmelin to conclude that the same species must have been independently *created at many distinct points* and we might have remained in this same belief had not Agassiz and others called vivid attention to the Glacial period which as we shall immediately see affords a simple explanation of these facts We have evidence of almost every conceivable kind organic and inorganic that within a very recent geological period central Europe and North America suffered under an arctic climate The ruins of a house burnt by fire do not tell their tale more plainly than do the mountains of Scotland and Wales, with their scored flanks, polished surfaces, and

perched bould s, f th treams w th which the all w relat ly filled So greatly has th clim te f E rope hanged th t i north rn Ital g gant c m rain s, l ft by ld glaci rs, are now lotl ed by th vine and maize Thro gh t large part of the United tates, rr tic bo lders and sco ed ocks pla ly

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rope as xplained b Edward F be b- tant ally as f ll ws. B t w shall f ll w tl e hanges m re read ly by ppo ing ew glacial period l ly t com on, and tl n pass as f rm ly occu red As the cold m n, and as ach m re so th rn *became* fitted f the inhab tants f the rth these ld take the places f th f rm nhal tants f th t mpe t reg ns. Th latt at th sam tim w ld tra l f rth and fur th so thward nless th y w re *topped by* barr rs, in which case th y w ld perish The m untains w ld becom co red with sn w and ice and th ir f rm Alp nhab tants w ld d sce d t th plains. By th tim tl t *th cold had reached ts ma imum* w l ld h an arctic fauna and fl ra, co ring th ce tral parts f E rope as far so th as th Alps and P re ees, and tretch g to pain. Th w t mperat regi ns l th United States w ld like ise b co red by arct plants and animals and th se uld be n arly th sam w th th se f E rope f th prese t *rcumpolar nhab tants, which* w ppose to ha ywh re tra lled so thward are re markably mf rm d th w ld

As th armth ret rned th arctic f rm ld tre t thw rd, losely f ll wed p th *retre t* b th prod t ns f th m re t mpe t reg ns. And as th n w m lted from th base f the m tains, th arct c f rm w ld ze n th l ared and th ed ground alw asce di g as th warmth in reased and th sn w t ll f rthe d sappeared high and h gh whilst th ir brethre w re p uing th ir rth rn j rn y H ce wh n th warmth had fully returned th sam pe cies, h h had l t l h ed tog th n th European and N rth Am rican l wlands, w ld gain be f und th arcti reg ns f th Old and New W lds, and many iso- lated mountain mmit far d tant from ach th

Th w can u d rstand th dent ty f many plant t po ts so imm sely rem t as tl t is f th United States and those f E rope We can thu also understand tl fact tl t th Al e plar t f each m untain range are m re pec all rel ted t tl e arctic f rms h g d n tl or ly d n rtl of them f r th f t m grat wl n the cold cam n, and the re n g at n tl r turn g w mtl w ll g e all l a e been d so th and n rth Tl Al plar ts, f r ample f Scotlai l as remarked l y Mr H C W tson, a d th se f tl Py r nees, as rem ked b Ram d re m re y cially all ed to tl plants of th rn Scand a ia tl ose of tl U ted States to Lal ad r tl se of tl e n t n f S beri t tl rct c regi of tl t

E rope an ...

g ns we fi d tl sam pec o d t t m tain mm ts, w may alm t or l l tl t tl d nce tl t a cold cl mate f rm rly perm tted tl ir m g ation across tl e t rv m g l wl nds, n w become too w f tl e iste ce

As the arctic f rms m ed first so tl w rd a d aft rward backward to th nortl n uniso w th the changi g climate th y w ll n t h been e posed d ri th l g t n t any gre t d rsity of t mperat re and as th y all gr ted in a body t gell th m t al relat ns will n t ha been m l *disturbed. H nce in accordance witl th* pri cipl in lcated in this l m these f rn w ll n t ha bee liable t m cl mod ficat o B t w th th Alpin prod t ns, l ft isolated from th m m t f tl turning warmtl

th sam arct c peci w ll l bee l ft n m tain ang f distant f m ach otl and ha urv ed there e r ce *th y w ll* also in all probab l t h becom m led w th anci nt Alpine pec s, wh h must h e isted n th t b f re th com m cem t f tl Glac al poch, and wh d d ing th cold t pe od will l been t m porarily dri n d wn t th plains th y w ll also ha bee bseq ently xposed to some wh t different cl matal infl ces. Th m tual rel t ns w ll th l e been in som d gree d t bed conseq ntly they w ll h been liabl to mod ficat n and th y h bee modified f f w mpare tl prese t Al e

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pt —
tant ally as f ll ws. B t w sh ll f llow the l anges m re r adily by ppo g n w glacial pe od sl ly t om n, and th pass y as f rm ly occurred A the cold came n, and as ach m re so th n o becam fitted f r th inl b tants f tl n rtl th se ld tak the place f the f rm inh l tant f th t mp t g ns. The l tt r t th sam tim w uld t el furth and f t w l l th w e topped by

w ld d se d t tl pl ins. By th t me tl t th cold had reached ts m imum we ho ld

Spain. Th wt mp t reg ns f the U ted States w ld likew se b co red by arcti plants and an mals and th se wo ld b arly th sam w th th se f E rope f th p se t rcumpolar nh b tants, wl ch w ppose t b y wh t lled so thward ar re m kably unif rm d th w ld

As th armth t rned th arct f rm w ld t t thw rd, l sely f ll wed p th t t b th p od t ns f th m re t mpe t reg s. And as th w m lted from th base f tl m tains th ar tic f rm ld se n th l ared and th wed g und al y asce d g as th warmth in creased and th w till furth disapp ared h gh d h h whilst th b thr n w re p g tl ir rth rn j rn y H ce wh n th armth had fully ret rned th sam pe ci wh h had l t lv l ed t g tl tl E ropean and N rth Am an l l d ld gai b f d n th arct reg f tl Old and N w W lds, and n many so. lat d m u ta n mmt far d t nt from acl th

Thus an und rstand th d t ty f many plant t points so imm usely rem t as tl m unta ns f th U nited Stat d thos

of Eu fact t ra g form tl m fo tl e f rst migrati wl n tl e col l ca n, d tl re m g at o n tl r turn g w rn tl w ll g ally l a e been d soutl ar d th Tl e Alp plar ts, f r mpl f Scotla d as r mark d l Mr H C W tso d th f tl Pyr nees, as re kcd by Ra d are re pec ally ll ed to tl plar ts f n tl rn Scar d na tl ose of tl U n ted Stat t Lal ad r tl se of tl e o to f S l t tl rct c reg n of th t

E rope u g n we fi d tl e sam spec d t t m tai mm ts, we n ay alm t cor l l w tl ut tl r d ce tl t a cold r l m te forme ly p rm tted tl e m gration across tl e ter m g l lands w become too war

w ll t h been l abl to m d n od fie t B t w th tl Alp prod t ns, l ft isol ted f m th m m nt f tl e t rn g warmth first t th bas l ult m t ly t tl u m ts f th m tai is, the case w ll l v bee som wl t d ff re t f t is n t l k ly th t ll th same arct pec w ll l been l ft n m tai ang far distant from ach tl and ha rvi ed th re nce tl y ll also in all prob l l ty h l ecom mingled w th anci nt Alpin pecies, wl h mu t l ted tl untai b f th com m cem t f th Gl l poch and whi cl d rin the cold t pe od will l a been t m po arily dri d wn t th plains they w ll also h bee bseq tl posed to some wh t diff t cl matal infl nces. Tl mut al l t ns w ll tl f e been n som d gree dist rbed conseq tl tl y will h bee l bl to modifi t n an l th y l bee mod fied f f w comp tl prese t Alj e

plants and animals of the several great European mountain ranges one with another, though many of the species remain identically the same, some exist as varieties, some as doubtful forms or sub-species, and some as distinct yet closely allied species representing each other on the several ranges.

In the foregoing illustration I have assumed that at the commencement of our imaginary Glacial period the arctic productions were as uniform round the polar regions as they are at the present day. But it is also necessary to assume that many sub-arctic and some few temperate forms were the same round the world, for some of the species which now exist on the lower mountain slopes and on the plains of North America and Europe are the same; and it may be asked how I account for this degree of uniformity in the sub-arctic and temperate forms round the world at the commencement of the real Glacial period. At the present day the sub-arctic and northern temperate productions of the Old and New Worlds are separated from each other by the whole Atlantic Ocean and by the northern part of the Pacific. During the Glacial period, when the inhabitants of the Old and New Worlds lived farther southward than they do at present, they must have been still more completely separated from each other by wider spaces of ocean; so that it may well be asked how the same species could then or previously have entered the two continents. The explanation I believe lies in the nature of the climate before the commencement of the Glacial period. At this, the newer Pliocene period, the majority of the inhabitants of the world were specifically the same as now, and we have good reason to believe that the climate was warmer than at the present day. Hence we may suppose that the organisms which now live under latitude 60°, lived during the Pliocene period farther north under the Polar Circle, in latitude 66°-67°; and that the present arctic productions then lived on the broken land still nearer to the pole. Now if we looked at a terrestrial globe, we see under the Polar Circle that there is almost continuous land from western Europe, through Siberia, to eastern America. And this continuity of the circumpolar land, with the consequent freedom under a more favourable climate for intermigration, will account for the supposed uniformity of the sub-arctic and temperate productions of the Old and New Worlds, at a period anterior to the Glacial epoch.

Believing, from reasons before alluded to, that our continents have long remained in nearly the same relative position, though subjected to great oscillations of level, I am strongly inclined to extend the above view, and to infer that during some still earlier and still warmer period, such as the older Pliocene period, a large number of the same plants and animals inhabited the almost continuous circumpolar land; and that these plants and animals, both in the Old and New Worlds, began slowly to migrate southward as the climate became less warm, long before the commencement of the Glacial period. We now see, as I believe, their descendants, mostly in a modified condition, in the central parts of Europe and the United States. On this view we can understand the relationship with very little identity, between the productions of North America and Europe,—a relationship which is highly remarkable, considering the distance of the two areas, and their separation by the whole Atlantic Ocean. We can further understand the singular fact remarked on by several observers that the productions of Europe and America during the later tertiary stages were more closely related to each other than they are at the present time; for during these warmer periods the northern parts of the Old and New Worlds will have been almost continuously united by land, serving as a bridge, since rendered impassable by cold, for the intermigration of their inhabitants.

During the slowly decreasing warmth of the Pliocene period, as soon as the species in common, which inhabited the New and Old Worlds, migrated south of the Polar Circle, they will have been completely cut off from each other. This separation, as far as the more temperate productions are concerned, must have taken place long ages ago. As the plants and animals migrated southwards, they will have become mingled in the one great region with the native American productions, and would have had to compete with them; and in the other great region, with those of the Old World. Consequently we have here everything favourable for much modification,—for far more modification than with the Alpine productions, left isolated, within a much more recent period, on the several mountain ranges and on the arctic lands of Europe and N. America. Hence it has come, that when we compare the now living productions of the temperate regions of the New and Old Worlds, we find very few identical species (though Asa Gray has lately

shown that more plants are identical than was formerl supposed) b t w find in rv gre t class man forms, which som naturalists rank as geographical races, and oth rs as distinct species and host of losel allied or representative forms which are ranked by all naturalists as specificall d stinct.

As on th land, so in th w t rs of th sea, a low southern migration of a mari e fauna, which, during the Plioce n o en a somewhat earlier period, was nearly uniform along the continuous shores of th Polar Circle, will

can understand the presence of som closely allied, still xisting and xtinct tertiary forms, on the east rn and west rn shores of t mperate North America and th till more striking fact of m losel allied crustaceans (as

two areas ...
the breadth of whol continent and b wid spaces of ocean.

These cases of close relationship in pecies either now f rm rl inhab ting th seas on the eastern and west rn shores of N rth America, the Mediterranean and Japan, and the temperat land of North Am rica and Europe are inexplicab the theory of cre tion. W cannot maintain that such pecies ha been created alike in correspond nce with the n arly similar ph sical conditions of th areas for if w compare f instance certain parts of South America with parts of South Africa or Australia, w see countries closel similar in all th ir ph sical conditions, with th ir inhabitants tt rl dissimilar

Alternate Gl al Periods n the North and South

B t w must return to our more immediat subject. I am convinced that F rbes view ma be largel extended In Europe w meet with th plainest idence of th Glacial period, from th west rn shores of Britain to the Oural range and southward t the P renees. W ma inf from th froze mammals and nature of th m untain egetation, that Siberia was similarl affected. In th Lebanon, according to D Hooker perpetual snow f merl co ered th central axis, and fed glaciers which rolled 400 feet d wn th valle s. Th same observer has recently found great moraines t l w l el n the Atlas range in N Africa. Along th Himala a, t points 900 miles part, glaci rs ha l ft th marks of their former low descent and in S kkim, Dr Hooker saw maize growi on ancient and gigantic moraines. So *thward of the Asiatic* contine t, n th pposite side of th equator we know from th excelle t researc es of Dr J Haast and Dr Hect r that in New Zealand immense glaci rs form ly descended to a low le l and th same plants f und by D Hook n widely separated mountains in this island t ll th sam tory of a form r cold period From facts communicated to me by th R v W B Clark t ppears also that th re are traces of form glacial action on th mountains of the so th-eastern corner of Australia.

Lookin to Am rica in th north rn half ice-born fragments of rock have been observed on th east rn side of the co tin nt, as far so th as lat. 36°-37° and on the shores of the Pacific, wh re the climate is now so diff r ent, as far south as lat. 46° Erratic bould rs ha e also been noticed o th Rocky Mountains. *In th Cordillera of South Am rica,* nearly und th equator glaciers once t nded far below their present le el. I Central

nforms m that h found in arious part of th Cordillera, from lat. 13° to 30° S., t abo t th h ght of 12,000 feet, deeply f rro ed rocks, resembling those w th which h w *familiar in* Norw y and likewise great ma ses of d tritus, including groo ed pebbles. Along this whole pace of th Cordillera true glaci rs do not xi t ven t m ch more considerable heights. Farth south n both sides of th contin t, *from lat. 41 to the so thernmost* xtremity w ha th clearest vid nce of form glacial action, in um rous imm nse boulders transported far from their pare t source

From these se ral facts, nam ly from th glacial action h ving ext nded all round th north rn and so th rn h mispheres—from the period having been in geolo ical sense recent in both h misph res—from ts having la ted in both during a great length of time, as ma be inf rred from th amount of work affected—and lastl from glaci rs having recently descended to a low le l alo the whole lin of the Cordillera, t t on tim ppeared to me that w could not void the conclusion that

the temperature of the whole world had been simultaneously lowered during the Glacial period But now Mr Croll in a series of admirable memoirs has attempted to show that a glacial condition of climate is the result of various physical causes brought into operation by an increase in the eccentricity of the earth s orbit All these causes tend towards the same end but the most powerful appears to be the indirect influence of the eccentricity of the orbit upon oceanic currents According to Mr Croll cold periods regularly occur every ten or fifteen thousand years and these at long intervals are extremely severe owing to certain contingencies of which the most important as Sir C Lyell has shown is the relative position of the land and water Mr Croll believes that the last great Glacial period occurred about 240 000 years ago and endured with slight alterations of climate for about 160 000 years With respect to more ancient Glacial periods several geologists are convinced from direct evidence that such occurred during the Miocene and Eocene formations not to mention still more ancient formations But the most important result for us arrived at by Mr Croll is that whenever the northern hemisphere passes through a cold period the temperature of the southern hemisphere is actually raised with the winters rendered much milder chiefly through changes in the direction of the ocean currents So conversely it will be with the northern hemisphere whilst the southern passes through a Glacial period This conclusion throws so much light on geographical distribution that I am strongly inclined to trust in it but I will first give the facts which demand an explanation

In South America Dr Hooker has shown that besides many closely allied species between forty and fifty of the flowering plants of Tierra del Fuego forming no inconsiderable part of its scanty flora are common to North America and Europe enormously remote as these areas in opposite hemispheres are from each other On the lofty mountains of equatorial America a host of peculiar species belonging to European genera occur On the Organ mountains of Brazil some few temperate European some Antarctic and some Andean genera were found by Gardner which do not exist in the low intervening hot countries On the Silla of Caracca the illustrious Humboldt long ago found species belonging to genera characteristic of the Cordillera

In Africa several forms characteristic of Europe and some few representatives of the flora of the Cape of Good Hope occur in the mountains of Abyssinia At the Cape of Good Hope a very few European species believed not to have been introduced by man and on the mountains several representative European forms are found which have not been discovered in the intertropical parts of Africa. Dr Hooker has also lately shown that several of the plants living on the upper parts of the lofty island of Fernando Po and on the neighbouring Cameroon mountains in the Gulf of Guinea are closely related to those on the mountains of Abyssinia and likewise to those of temperate Europe It now also appears, as I hear from Dr Hooker that some of these same temperate plants have been discovered by the Rev R T Lowe on the mountains of the Cape Verde Islands This extension of the same temperate forms almost under the equator across the whole continent of Africa and to the mountains of the Cape Verde Archipelago is one of the most astonishing facts ever recorded in the distribution of plants

On the Himalaya and on the isolated mountain ranges of the peninsula of India, on the heights of Ceylon and on the volcanic cones of Java many plants occur either identically the same or representing each other and at the same time representing plants of Europe not found in the intervening hot lowlands A list of the genera of plants collected on the loftier peaks of Java raises a picture of a collection made on a hillock in Europe! Still more striking is the fact that peculiar Australian forms are represented by certain plants growing on the summits of the mountains of Borneo Some of these Australian forms as I hear from Dr Hooker extend along the heights of the peninsula of Malacca and are thinly scattered on the one hand over India and on the other hand as far north as Japan

On the southern mountains of Australia, Dr F Müller has discovered several European species other species not introduced by man occur on the lowlands and a long list can be

large island Hence we see that certain plants growing on the more lofty mountains of the tropics in all parts of the world and on the temperate plains of the north and south are

eith th sam pec o n t s f tl sam spec es It sh ld l o e c be b-er ed th t these l t n t tn tl) arct c f rms f r as M

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and cl sely all ed forms, n any pecie in hab t g th sam w d ly d red areas, be-l ngtog a tnow f d tl te med ate trop cal l wlands.

Th se bn f remarks pply t pl nts al n b t some f anal g fact co ld be gi in regard t terrestrial an mal I m t pro-d t ns m l cases l k w se occ r as an ampl I m y q t a tat m nt by tl e h gl t th nty Prof Dana, th t It i ce ta: ly a w d rful fact tl t N w Z al l

f N w Ze l nd Tasm a, &c f n rtl rn f rms f fi l D Hook nf rm m tl t t t fi pec f Alg com n n to N w Zealand and to E rope l t l t bee f d th t med te t p cal seas.

From th f g g fact nam ly tl p s-ce f t mpe t f m th h ghlands acro th wh le f eq torial Af ca, and al g th P ns la f Ind a, t C ylo and tl M l trcl pelag d n les w ll marked an acro th w d pans f trop cal So th Am rica, t ppears lm t certai th t t som f m period n d bt d in th m t se p rt f Glacial pe od tl l wl d f th se g t co t ts w y h t nanted nd tl q to by a cons d bl umbe of t mpe t f rms. At tl is period th eq tori l lim t t tl l l f th was p b bly abo t tl sai w th th t w perı ced t th h ght f from fi t th usand feet u d r th m lati-t d pe h p th cool D n g th s, th cold t pe od, th l wland d th equato must l bee l thed w th m gled tr p cal d t mpe t g tat n, l k that d scr bed by Hook as grow g l nantly t th h ght f from f to fi th d f t th l l pe f tl H malaya, b t w tl pe l p t l gr t p pond ance f tem pe t f ms. So agai th m t isla d f F rnand l o, th Gulf f G a, M Man f d t mpe t E ropean f ms beginni g to pp ar t th h gl t f ab t fi th sa d f t O tl m t f Panama,

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N w l t us see wl tl er Mr Croll co clu tl t wl the rtl ernl e s phere ff red fro tl e e tre e col l f tl great Glac l per od tl so th rn l m pl re was act lly warn tl ro s a y cl r l gl t tl p s t apparently t xpl bled t b t of vari ga m the t pe t part f botl l m p h es, a d n tl e m ntains of tl t p s. Tl e Glac l pe i l as n as red by y ars, m t l y been ry l g n l wl i we

f any am t f grat n. A tl cold be-came re an l m re tense w k w tl t arct f rm aded tl e t pe te regi ns and fr m th fact y t g n, tl can l ardly

same time ha e g t d t tl troj al and btr p cal regi f tl s tl f r tl e so th ern h m pl a. t tl is period warm On tl decli f tl Glacial period a. botl l m pl re g ad all rece red tl f rm t m perat res, th tl te pe te f rm l g on tl l wl d l tl eq tor would l y been d i n t tl r f rm l m s o l been d st yed l g rej laced l y the eq torial f m r t g f the so tl Som h f tl tl m t pe t f rm s w ld alm t e t nly l asc ded a y adj ni g h gl la l where f ff ntl l fty tl ey w ld l l g rı d l k tl arct f rm tl m t ns of E rope Th y m ght l a e urv ed n if the l te was t pe fectly fitted f tl em f rtl ecl ang ft mper tur m t l bee low ar d plants nd btedly posse s a ce t n j ac ty f accl m tisat as l n by th r t m tt g t tl off j g diff nt co t tu t l pow f ust ng l t l cold I tl r g l rse f t tl so tl ern l m ph w ld i ts t rn be bjected to a se Glaci l pe od w th tl tl rn h m ph re d ed arme d tl tl south te pe te f rm w ld ad th eq a torial l wlands. Tl orth rn f m wl ch had bef re b l ft th m nt w ld n w d sc d and m gl w tl th so th n f ms

These latter when the warmth returned would return to their former homes leaving some few species on the mountains, and carrying southward with them some of the northern temperate forms which had descended from their mountain fastnesses. Thus we should have some few species identically the same in the northern and southern temperate zones and on the mountains of the intermediate tropical regions. But the species left during a long time on these mountains or in opposite hemispheres would have to compete with many new forms and would be exposed to somewhat different physical conditions; hence they would be eminently liable to modification and would generally now exist as varieties or as representative species and this is the case. We must also bear in mind the occurrence in both hemispheres of former Glacial periods for these will account in accordance with the same principles, for the many quite distinct species inhabiting the same widely separated areas and belonging to genera not now found in the intermediate torrid zones.

It is a remarkable fact strongly insisted on by Hooker in regard to America, and by Alph de Candolle in regard to Australia, that many more identical or slightly modified species have migrated from the north to the south than in a reversed direction. We see however a few southern forms on the mountains of Borneo and Abyssinia. I suspect that this preponderant migration from the north to the south is due to the greater extent of land in the north and to the northern forms having existed in their own homes in greater numbers and having consequently been advanced through natural selection and competition to a higher stage of perfection or dominating power than the southern forms. And thus when the two sets became commingled in the equatorial regions during the alternations to the Glacial periods the northern forms were the more powerful and were able to hold their places on the mountains and afterwards to migrate southward with the southern forms but not so the southern in regard to the northern forms. In the same manner at the present d[illegible] two or three centuries from La Plata and during the last forty or fifty years from Australia. The Neilgherrie mountains in India, however offer a partial exception for here as I hear from Dr Hooker Australian forms are rapidly sowing themselves and becoming naturalised. Before the last great Glacial period no doubt the intertropical mountains were stocked with endemic Alpine forms but these have almost everywhere yielded to the more dominant forms generated in the larger areas and more efficient workshops of the north. In many islands the native productions are nearly [illegible]

[illegible] islands on the land and their inhabitants have yielded to those produced within the larger areas of the north just in the same way as the inhabitants of real islands have everywhere yielded and are still yielding to continental forms naturalised through man's agency.

The same principles apply to the distribution of terrestrial animals and of marine productions in the northern and southern temperate zones and on the intertropical mountains. When during the height of the Glacial period the ocean currents were widely different to what they now are some of the inhabitants of the temperate seas might have reached the equator; of these a few would perhaps at once be able to migrate southward by keeping to the cooler currents, whilst others might remain and survive in the colder depths until the southern hemisphere was in its turn subjected to a glacial climate and permitted their further progress in nearly the same manner as according to Forbes isolated spaces inhabited by arctic productions exist to the present day in the deeper parts of the northern temperate seas.

I am far from supposing that all the difficulties in regard to the distribution and affinities of the identical and allied species, which now live so widely separated in the north and south and sometimes on the intermediate mountain ranges are removed on the views above given. The exact lines of migration cannot be indicated. We cannot say why certain species and not others have migrated; why certain species have been modified and have given rise to new forms whilst others have remained unaltered. We cannot hope to explain such facts, until we can say why one species and not another becomes naturalised by man's agency in a foreign land [illegible] species

ran_es twice thrice as far and is tw ce r three as common, as an th r species w thin their wn homes.

Varıou special difficulties also remain to be sol ed for instance th occurrence as sh wn b D Hooke of th sam plant at points so enormously remot as K rguel n Land, N w Zealand, and Fuegia b t icebergs, as ggested b L ll, may ha bee co cern d in th ir dispersal. The xistence at these and othe distant points of th so th rn h misph re of species, which, th gh dist ct, bel g to genera xclusi el confined t th so th, is a more remarkabl case Som of these pec es are so distinct, that we cann t ppose that there has bee tim ince th comm ncem nt of th last Glacial period f r th ir migrati n and subsequent modifi t t th necessary d gree. Th facts seem t ind cate that distinct species belo ing to th sam g nera ha migrated in radiating lines from comm centre and I am inclined to look in th so th rn, as in the north rn h m ph re to a form and warm period bef re th comm ncem t of th last Glacial period, wh th Antarctic lands, n w co red w th ice, suppo ted hi hl peculiar and isolated flora. It ma be u pected that before this flora was xt rminated d ri g th last Glacial poch, f w f rms had bee already wid dispersed to arious points of the south rn h m ph re b occasi nal m ans of transport, and b th aid as halting places, of now unken islands. Thus th so thern

throughout th world ...

b tı n. And w ha n w seen that M Croll s conclu n that ccess Glacial pe od in th o e h mı ph re coincide w th warm r per iods th pposite h misph re, tog th r with th admis ion of the slow modificati n of pec es, plains a multitud of facts in th distrib tio of th same and of th all ed f rms of lif all parts of the globe The li ing w ters ha fl wed during on period from th north and during another from the south, and in both case ha e reached th equat b t the tream of life has flowed w th gre ter force from th n rth than in th opposite directi n, and has conseq tly m re freel undated th so th. As th tid lea es ts drift in hori zontal lines, rising highe on the shores wh re the tid rises highest, so ha e the li n wat rs l ft th ir li ng drift n our m unta n um mits, in lin g ntly rising from the arctic l wlands t a great alt t d und the equ tor Th an us being thus left tranded ma be compared w th sa ge aces of man, dri n p and urv g n the m untain fastnesses f almo t ry land, which serves as a record, full of int rest to us, of th f rmer inhab tants of th urro ding lowlands.

CHAPTER XIII

GEOGRAPHICAL DISTRIBUTION *Continued*

Fresh water Productions

As LAKES and river systems are separated from each other by barriers of land it might have been thought that fresh water produc

still more formidable barr er t a y ou u never have extended to distant countries But the case is exactly the reverse Not only have *many fresh water species* belonging to differ ent classes an enormous range but allied spe *cies prevail in a remarkable manner throughout* the world When first collecting in the fresh water of Brazil I well remember feeling much surpri e at the similarity of the fresh water in *sects* shell &c and at the di similarity of the surrounding terre trial beings compared with those of Britain

But the wide ranging power of fresh w ter productions can I think in most cases be ex plained by their having become fitted in a manner highly useful to them for hort and frequent migrations from pond to pond or from stream to stream within their own coun *tries* and
follow from
sary conse
few cases of these some of the most difficult to explain are presented by fish It was for merly believed that the ame fresh water species never exi ted on two continents di tant from each other But Dr Günther has lately shown that the *Galaxias attenuatus* inhabits Tasmania New Zealand the Falkland Islands and the mainland of South America. This is a wonderful case and probably indicates dis persal from an Antarctic centre during a former warm period This case however is rendered in some degree less surprising by the species of this g is having the power of crossing by some
open
to Ne I
though separated by a distance of about 230 miles On the same *continent fresh* ater fish *often* range widely and as if capriciously for in two adjoining river syst ms some of th species may be the same and some wholly different.

It is probable that they are occasionally tran ported by what may be called accidental

mainly attributed to changes
land within the *recent period* cau ing rivers to flow into each other Instances also could be given of this having occurred during floods, without any change of level The wide differ *ence of the fish on the oppo ite ides of most* mountain ranges which are continuous, and which consequently must from an early period have completely prevented the inosculation of *the river systems on the two si le lea ls to the*

for much migration Moreover Dr Günther ha recently been led by everal considerat ons to infer that with fi hes the same forms have a long endurance Salt water fish can with care *be slowly accustomed to live in fresh water* and accor ling to Valenciennes there is hardly a single group of which all the members are confined to fre h water so that a marine pe *cies belonging to a fre h water group* might travel far along the shores of the sea, and could it is probable become adapted with t much difficulty to the fre h waters of a distant land

Some pecies of fre h water shells have very wide range and allied pecies which on our theory are descended from a common parent, *and must have proceeded from a single source* prevail throughout the world Their distribu tion at first perplexed me much as their ova are not likely to be transported by birds and *the ova as w ll as the adult are immediately* killed by sea-water I could not even under stand how some naturali ed species have spread rapidly throughout the ame country *But two facts which I ha e observed*—and many others no doubt will be discovered—throw some light on this ubject When ducks suddenly emerge from a pond covered with duck weed I have twice se n these little plants

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islands. This triki gl ll tr ted according
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occas ally adh som q antity t the
feet and beaks f birds. Wad g b rds, wh ch
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m ddy f t. Bird f this rd wand r m re
than those f y th and th y re occas n
ally f und th m t rem t and bar n
lands f th pe ocean th y w uld n t be
lik ly to al ght th rfac of th sea, so
that any d t n their feet w ld n t b washed
ff and wh gai g th land they w uld be
re to fly to thei n t al fre h w te h u ts.
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charged th m d f po ds is w th seed I h
tried se al littl perim ts, b t w ll h re
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Th sam ge y may ha e co e into play
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intruder from the waters of a foreign country would have a better chance of seizing on a new place than in the case of terrestrial colonists We should also remember that many fresh water productions are low in the scale of nature and we have reason to believe that such beings become modified more slowly than the high and this will give time for the migration of aquatic species We should not forget the probability of many fresh water forms having formerly ranged continuously over immense areas and then having become extinct at intermediate points But the wide distribution of fresh water plants and of the lower animals whether retaining the same identical form or in some degree modified apparently depends in main part on the wide dispersal of their seeds and eggs by animals more especially by fresh water birds which have great powers of flight and naturally travel from one piece of water to another

On the Inhabitants of Oceanic Islands

We now come to the last of the three classes of fact which I have selected as presenting the greatest amount of difficulty with respect to distribution on the view that not only all the individuals of the same species have migrated from some one area but that allied species although now inhabiting the most distant points have proceeded from a single area — the birthplace of their early progenitors I have already given my reasons for disbelieving in continental extensions within the period of existing species on so enormous a scale that all the many islands of the several oceans were thus stocked with their present terrestrial inhabitants This view removes many difficulties but it does not accord with all the facts in regard to the productions of islands In the following remarks I shall not confine myself to the mere question of dispersal but shall consider some other cases bearing on the truth of the two theories of independent creation and of descent with modification

The species of all kinds which inhabit oceanic islands are few in number compared with those on equal continental areas Alph de Candolle admits this for plants and Wollaston for insects New Zealand for instance with its lofty mountains and diversified stations extending over 780 miles of latitude together with the outlying islands of Auckland Campbell and Chatham contain altogether only 960 kinds of flowering plants if we compare this moderate number with the species which swarm over equal areas in South Western Australia or at the Cape of Good Hope we must admit that some cause independently of different physical conditions has given rise to so great a difference in number Even the uniform county of Cambridge has 847 plants and the little island of Anglesea 764 but a few ferns and a few introduced plants are included in these numbers, and the comparison in some other respects is not quite fair We have evidence that the barren island of Ascension aboriginally possessed less than half a-dozen flowering plants yet many species have now become naturalised on it, as they have in New Zealand and on every other oceanic island which can be named In St Helena there is reason to believe that the naturalised plants and animals have nearly or quite exterminated many native productions He who admits the doctrine of the creation of each separate species will have to admit that a sufficient number of the best adapted plants and animals were not created for oceanic islands for man has unintentionally stocked them far more fully and perfectly than did nature

Although in oceanic islands the species are few in number the proportion of endemic kinds (i e those found nowhere else in the world) is often extremely large If we compare for instance the number of endemic land shells in Madeira or of endemic birds in the Galapagos Archipelago with the number found on any continent and then compare the area of the island with that of the continent we shall see that this is true This fact might have been theoretically expected for as already explained species occasionally arriving after long intervals of time in the new and isolated district and having to compete with new associates would be eminently liable to modification and would often produce groups of modified descendants But it by no means follows that because in an island nearly all the species of one class are peculiar those of another class or of another section of the same class are peculiar and this difference seems to depend partly on the species which are not modified having immigrated in a body so that their mutual relations have not been much disturbed and partly on the frequent arrival of unmodified immigrants from the mother country with which the insular forms have intercrossed It should be borne in mind that the offspring of such crosses would certainly gain in vigour so that even an occasional cross would produce more effect than might have

bee anticipated I w ll gi e f w llu t ti ns of th f reg ing rem rk n tl G lap go Islands there ar 6 land b rd f th se 1 (o pe h p .3) are pec l wh reas of th 11 *marr bird* nl are pec l ar an l t i obvious th t marin bird co ld arri e t tl se islands m ch m re as ly and freq tl than land birds. B rm da, n tl tl l and wh ch lies t abo t th sam d tance from N rth Am ca as th Gal p g Islands d from So th Am n d which has a ry pecul so l b rd adm man

f eq tly is t th land Am t ar as I am inf med by M E V Harco t man *E ropean and Afri an b rd are bl w* to Mad ra this island is nhab ted b 99 kind f which alon is pecul ar tl gh rel ted t E rope n f rm and

g ther and ha becom m t ally co-adapted

t d y to modifi t ll also l be n checked by int rcrossing w tl th unmodified imm g ants, ft n arri ing from tl m tl er co try Mad agai is inhab ted b w derf l mbe f peculiar land sh lls, wh as t pecies f se sh ll pecul to t

dred m les f pe se far m re as ly than land h lls. Th d ff rent rders f insects nhab ting Mad prese t nearly parall l cases.

Ocean island re som tim d fici t in an mals f certai wh l lasses, and th

N w Ze land is h re pok n f as an oceani l d t is in som d eed btf l wh th t l ld be so ranked t f l g ız and is t separ ted from A t al by prof undly deep se from its geol gical cl aracter and th d recti n of t m u t n a g s, tl e Re W B Clark l as lately mainta ned tl at th s island as w ll as N w Caled n a, sh ul l be con s l red as p[u t ance of Au t l a. Turni g t plants, Dr Hook r l as l wn tl at n tl e Galap. I l l tl e p po ti n l n l s f tl wl t

n n m ic

gro ps f mals and plants, are ge ally ac *cou ted f r by pposed d ff re ces n tl* ph cal co d t of tl e la d but thi expl nati is n t a l ttl do l tf l Fac l ty of *imm g t n seem t l a l een fully as im* portant as tl nat re f tl e co d t s.

Many remark bl l ttl facts coul l be gi n w tl respect t tl nh bitants f ocean c islands. F instance n ce t n land n t t anted by a ngle mamm l som f the e d m plant l b t f lls l ooked seed y t few rel t n are m re manif t tl an tl at *l ooks serve f tl t n portal of seed in the* wool f r f q ad peds. B t l ooked seed m ght be car ed t a i land by th r m ans and tl plant tl en becom g mod fied w ul l f rm an ndem c pec s, t ll retai ng its hooks, wl h w ld f rm useless ppend ge lik th sh lled wings u d th soldered w g-co rs f many n lar beetles. Again, lands ften po ses t ee b she b l ging to rd rs wh ch lse l l d nly l baceo pec n w trees, as Alpl de Can d ll has l wn g ally h wl te th ca se m be, confined rang s. H nce trees w ld be l ttl l k l t reach d tant oce nic land and an h b ce us plant, wl cl l ad n chance of cessf ll compet g w th th man f lly d l ped tree gro g on co ti t, m ght, wh n tablished an land gai an ad ant g th l baceous

to wh t rd t b l ged, and th first co t t into bush and th nt tree

Absence of B t h ans nd Terrestrial Mammals on O c c Isl nds

W th re pe t to th bse ce f wh l d f ammals n ocean c lands, B y St. V ce t l g g remarked th t hat ach ans (frogs, toads, wts) ar f und n any f the many island w tl whi h th gre t oceans are t dded I l e tak pains t fy thi assert n, and h f d t true, w th th cep-

tion of New Zealand, New Caledonia, the Andaman Islands, and perhaps the Solomon Islands and the Seychelles. But I have already remarked that it is doubtful whether New Zealand and New Caledonia ought to be classed as oceanic islands; and this is still more doubtful with respect to the Andaman and Solomon groups and the Seychelles. This general absence of frogs, toads and newts on so many true oceanic islands cannot be accounted for by their physical conditions: indeed it seems that islands are peculiarly fitted for these animals; for frogs have been introduced into Madeira, the Azores, and Mauritius, and have multiplied so as to become a nuisance. But as these animals and their spawn are immediately killed (with the exception, as far as known, of one Indian species) by sea-water, there would be great difficulty in their transportal across the sea, and therefore we can see why they do not exist on strictly oceanic islands. But why, on the theory of creation, they should not have been created there, it would be very difficult to explain.

Mammals offer another and similar case. I have carefully searched the oldest voyages, and have not found a single instance, free from doubt, of a terrestrial mammal (excluding domesticated animals kept by the natives) inhabiting an island situated above 300 miles from a continent or great continental island; and many islands situated at a much less distance are equally barren. The Falkland Islands, which are inhabited by a wolf-like fox, come nearest to an exception; but this group cannot be considered as oceanic, as it lies on a bank in connection with the mainland at the distance of about 280 miles; moreover, icebergs formerly brought boulders to its western

islands will not support at least small mammals, for they occur in many parts of the world on very small islands, when lying close to a continent; and hardly an island can be named on which our smaller quadrupeds have not become naturalised and greatly multiplied. It cannot be said, on the ordinary view of creation, that there has not been time for the creation of mammals; many volcanic islands are sufficiently ancient, as shown by the stupendous degradation which they have suffered, and by their tertiary strata: there has also been time for the production of endemic species belonging to other classes; and on continents it is

known that new species of mammals appear and disappear at a quicker rate than other and lower animals. Although terrestrial mammals do not occur on oceanic islands, aerial mammals do occur on almost every island. New Zealand possesses two bats found nowhere else in the world: Norfolk Island, the Viti Archipelago, the Bonin Islands, the Caroline and Marianne Archipelagoes, and Mauritius, all possess their peculiar bats. Why, it may be asked, has the supposed creative force produced bats and no other mammals on remote islands? On my view this question can easily be answered; for no terrestrial mammal can be transported across a wide space of sea, but bats can fly across. Bats have been seen wandering by day far over the Atlantic Ocean; and two North American species either regularly or occasionally visit Bermuda, at the distance of 600 miles from the mainland. I hear from Mr. Tomes, who has specially studied this family, that many species have enormous ranges, and are found on continents and on far distant islands. Hence we have only to suppose that such wandering species have been modified in their new homes in relation to their new position, and we can understand the presence of endemic bats on oceanic islands, with the absence of all other terrestrial mammals.

inhabitants. Mr. Windsor Earl has made some striking observations on this head, since greatly extended by Mr. Wallace's admirable researches, in regard to the great Malay Archipelago, which is traversed near Celebes by a space of deep ocean, and this separates two widely distinct mammalian faunas. On either side the islands stand on a moderately shallow submarine bank, and these islands are inhabited

instance, Britain is separated by a shallow channel from Europe, and the mammals are the same on both sides; and so it is with all the islands near the shores of Australia. The West Indian Islands, on the other hand, stand on a deeply submerged bank, nearly 1000 fathoms in depth, and here we find American forms, but the species and even the genera are quite distinct. As the amount of modification which animals of all kinds undergo partly depends on

th lapse of time, and as th i lands which are separated from ach th r from th main l nd by hall w chann ls, are m re lik l t ha bee continuously un ted with n a recent period than th islands separated by deeper chann ls, w can und rstand l w t is that a relation exists between th depth of th sea separating tw mammalian f unas, and th degree of their affinity — rel t n which is quit inexplicable n th theory f ind pend t acts of creatio

Th f regoing tatem nts regard t th inhab tants f oceanic islands,—nam l th f wness of the species, with larg proport o consisting f end m f rms,—the m mbers f certain gro ps, b t n t those of th gro p in th sam class, ha n been modified,—tl e absence f certa n wh l ord rs, as of b trach ians and of terrestrial mammals, notwith-standin th presence f aerial b ts,—tl singular proporti ns of certai ord rs f plants, —herbaceous f rms ha ing been d l ped into trees, &c.,—seem t m to accord bett with th belief in th ffici cy f occa nal means f transport, carried during a l ng course f time, than with th belief in th f mer connectio f all oceanic islands with th earest continent f n this l tt w t is probabl that th vari u lasses w uld ha immigrated m re unif rmly and from th spe-cies ha in ent red in bod th m tual relations w uld t ha been m ch disturbed, and conseq ently th y w ld eith ha n t bee modified, all th species in m re equable mann

wh the still retainin th sam specifi f rm or subseq tl modified, h reached th ir present homes. B t th probabil ty th islands having ce existed as halting places, of hich t a wreck w remains, must not be erlooked. I will pecify d fficult case. Almost all oceanic islands, n th m t so-lated and smallest, are inhab ted by land shells, g rally by nd mi species, b t some-times by species found lse here — triking instances of wh ch h been gi n by D A. A. G uld in relati n to th Pacific. N w t is noto us th t land sh lls are asily killed by sea-w t th ir eggs, t l ast su h as I h tried sink in t and are killed. Y t th re must be som unknown, b t occa nally ffici t m ans f th tran portal. W ld th just hatched young som tim adhere to th feet f birds roost ng on th gro nd and thus get tran ported It occurred to me that land wh h bernat ng and having a mem

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stand imm rs d an imm rsi n dur g se nd on sh ll tl *H lix pomat a,* aft ha ing been thus treated an l again h bernati g was p t t sea-w ter f r tw nty d ys, and perfectly reco red During th l ngth f t m th shell m ght h bee car rage wiftness,

th sea. Out of the hundred shells, tw t se n reco red The prese ce of an percul m seems t ha been of importance as t of tw l e pec m ns *(Cy lostoma l g* wl cl is th f rnished l revi ed It s remark able seeing h w well th *H l x pomat* re-sisted w th me the salt w te that n t o of fifty f ur pecim ns b l nging to f r oth r pecies of H lix tried by A cap tai e re-co red. It is, h w e t t all prol abl that land hells ha oft n been th trans-ported th feet of b rds of r a m re probable m thod.

O the Relat ons f the Inhabitants f Is l nds to those of the nearest Mainland

Th most triking and important fact f r us is tl affinity of th species which inhab t is-lands to those f the nearest mainland, with ut

f between 500 and 600 miles from th shores of South Am rica. H re alm t ry prod t of the land and f th w t bears the unm s-takabl stamp of th Am can co tin nt. Th re are tw ty six land birds f th se tw ty-one, pe hap tw nty thre are ranked as distinct pecies, and w uld comm nly be assumed to ha been here cre ted y t the close affinity of most of th se birds to Amer ican species is manifest in e ery character in their hab ts, gestures, and tones of voice. So t

is with the other animals and with a large proportion of the plants as shown by Dr Hooker in his admirable *Flora* of this archipelago The naturalist looking at th se al e merican land Why should this be so? Why should the species which are supposed to have been created in the Galapagos Archipelago and now so nl ed ons o ogical nature of the islands in their height or climate or in the proportions in which the several classes are associated together which closely resembles the conditions of the South American coast in fact there is a considerable dissimilarity in all these respects On the other hand there is a considerable degree of resemblance in the volcanic nature of the soil in the climate height and size of the islands between the Galapagos and Cape Verde Archipelagoes but what an entire and absolute difference in their inhabitants! The inhabitants of the Cape Verde Islands are related to those of Africa like those of the Galapagos to America Facts such as these admit of no sort of explanation on the ordinary view of independent creation whereas on the view here maintained it is obvious that the Galapagos Islands would be likely to receive colonists from America whether by occasional means of transport or (though I do not believe in this doctrine) by formerly continuous land and the Cape Verde Islands from Africa such colonists would be liable to modification —the principle of inheritance still betraying their original birthplace

Many analogous facts could be given indeed it is an almost universal rule that the endemic productions of islands are related to those of the nearest continent or of the nearest large island The exceptions are few and most of them can be explained Thus although Kerguelen Land stands nearer to Africa than to America the plants are related and that very closely as we know from Dr Hooker s account to those of America but on the view that this island has been mainly stocked by seeds brought with earth and stones on icebergs drifted by the prevailing currents, this anomaly disappears. New Zealand in its endemic planes is much more closely related to Australia, the nearest mainland than to any other region and this is what might have been expected but it is also plainly related to South America which although the next nearest continent is so enormously remote that the fact becomes an anomaly But this difficulty partially disappears on the view that New Zealand South America, and the other southern lands have been stocked in part from a nearly intermediate though distant point namely from the antarctic islands when they were clothed with vegetation during a warmer tertiary period before the commencement of the last Glacial period The affinity which though feeble I am assured by Dr Hooker is real between the flora of the south western corner of Australia and of the Cape of Good Hope is a far more remarkable case but this affinity is confined to the plants, and will no doubt some day be explained

The same law which has determined the relationship between the inhabitants of islands and the nearest mainland is sometimes displayed on a small scale but in a most interesting manner within the limits of the same archipelago Thus each separate island of the Galapagos Archipelago is tenanted and the fact is a marvellous one by many different species but these species are related to each other in a very much closer manner than to the inhabitants of the American continent or of any other quarter of the world This is what might have been expected for islands situated so near to each other would almost necessarily receive immigrants from the same original source and from each other But how is it that many of the immigrants have been differently modified though only in a small degree in islands situated within sight of each other having the same geological nature the same height climate &c ? This long appeared to me a great difficulty b t t

t e other pecies with which each has to comp te is at least as important, and generally a far more important element of success Now if we look to the pecies which inhabit the Galapagos Archip lago and are likewise found in other parts of the world we find that they differ considerably in the several islands This difference might indeed have been expected if the islands had been stocked by occasional means of transport—a seed for instance of one plant having been brought to one island and that of another plant to another island though all proceeding from the same general source Hence when in former

times an immigrant first settled on one of the islands, or when it subsequently spread from one to another, it would undoubtedly be exposed to different conditions in the different islands, for it would have to compete with a different set of organisms: a plant, for instance, would find the ground best fitted for it occupied by somewhat different species in the different islands, and would be exposed to the attacks of somewhat different enemies. If then it varied, natural selection would probably favour different varieties in the different islands. Some species, however, might spread and yet retain the same character throughout the group, just as we see some species spreading widely throughout a continent and remaining the same.

The really surprising fact in this case of the Galapagos Archipelago, and in a lesser degree in some analogous cases, is that each new species after being formed in any one island, did not spread quickly to the other islands. But the islands, though in sight of each other, are separated by deep arms of the sea, in most cases wider than the British Channel, and there is no reason to suppose that they have at any former period been continuously united. The currents of the sea are rapid and sweep between the islands, and gales of wind are extraordinarily rare; so that the islands are far more effectually separated from each other than they appear on a map. Nevertheless some of the species, both of those found in other parts of the world and of those confined to the archipelago, are common to the several islands; and we may infer from their present manner of distribution, that they have spread from one island to the others. But we often take, I think, an erroneous view of the probability of closely allied species invading each other's territory, when put into free intercommunication. Undoubtedly, if one species has any advantage over another, it will in a very brief time wholly or in part supplant it; but if both are equally well fitted for their own places, both will probably hold their separate places for almost any length of time. Being familiar with the fact that many species, naturalised through man's agency, have spread with astonishing rapidity over wide areas, we are apt to infer that most species would thus spread; but we should remember that the species which become naturalised in new countries are not generally closely allied to the aboriginal inhabitants, but are very distinct forms, belonging in a large proportion of cases, as shown by Alph. de Candolle, to distinct genera. In the Galapagos Archipelago, many even of the birds, though so well adapted for flying from island to island, differ on the different islands; thus there are three closely-allied species of mocking-thrush, each confined to its own island. Now let us suppose the mocking-thrush of Chatham Island to be blown to Charles Island, which has its own mocking-thrush; why should it succeed in establishing itself there? We may safely infer that Charles Island is well stocked with its own species, for annually more eggs are laid and young birds hatched, than can possibly be reared; and we may infer that the mocking-thrush peculiar to Charles Island is at least as well fitted for its home as is the species peculiar to Chatham Island. Sir C. Lyell and Mr. Wollaston have communicated to me a remarkable fact bearing on this subject; namely, that Madeira and the adjoining islet of Porto Santo possess many distinct but representative species of land-shells, some of which live in crevices of stone; and although large quantities of stone are annually transported from Porto Santo to Madeira, yet this latter island has not become colonised by the Porto Santo species: nevertheless both islands have been colonised by European land-shells, which no doubt had some advantage over the indigenous species. From these considerations I think we need not greatly marvel at the endemic species which inhabit the several islands of the Galapagos Archipelago, not having all spread from island to island. On the same continent, also, preoccupation has probably played an important part in checking the commingling of the species which inhabit different districts with nearly the same physical conditions. Thus, the south-east and south-west corners of Australia have nearly the same physical conditions, and are united by continuous land, yet they are inhabited by a vast number of distinct mammals, birds, and plants; so it is, according to Mr. Bates, with the butterflies and other animals inhabiting the great, open, and continuous valley of the Amazons.

The same principle which governs the general character of the inhabitants of oceanic islands, namely, the relation to the source whence colonists could have been most easily derived, together with their subsequent modification, is of the widest application throughout nature. We see this on every mountain-summit, in every lake and marsh. For Alpine species, excepting in as far as the same species have become widely spread during the Glacial

epoch are related to those of the surrounding lowlands thus we have in South America Alpine humming birds Alpine rodents Alpine plants &c all strictly belonging to American forms and it is obvious that a mountain as it became slowly upheaved would be colonised from the surrounding lowlands So it is with the inhabitants of lakes and marshes excepting in so far as great facility of transport has allowed the same forms to prevail throughout large portions of the world We see this same principle in the character of most of the blind animals inhabiting the caves of America and of Europe Other analogous facts could be given It will I believe be found universally true that wherever in two regions let them be ever so distant many closely allied or representative species occur there will likewise be found some identical species and wherever many closely allied species occur there will be found many forms which some naturalists rank as distinct species and others as mere varieties these doubtful forms showing us the steps in the progress of modification

The relation between the power and extent of migration in certain species either at the present or at some former period and the existence at remote points of the world of closely allied species is shown in another and more general way Mr Gould remarked to me long ago that in those genera of birds which range over the world many of the species have very wide ranges I can hardly doubt that this rule is generally true though difficult of proof Amongst mammals we see it strikingly displayed in bats and in a lesser degree in the Felidæ and Canidæ We see the same rule in the distribution of butterflies and beetles So it is with most of the inhabitants of fresh water for many of the genera in the most distinct classes range over the world and many of the species have enormous ranges It is not meant that all but that some of the species have very wide ranges in the genera which range very widely Nor is it meant that the species in such genera have on an average a very wide range for this will largely depend on how far the process of modification has gone for instance two varieties of the same species inhabit America and Europe and thus the species has an immense range but if variation were to be carried a little further the two varieties would be ranked as distinct species and their range would be greatly reduced Still less is it meant that species which have the capacity of crossing barriers and ranging widely as in the case of certain powerfully winged birds will necessarily range widely for we should never forget that to range widely implies not only the power of crossing barriers but the more important power of being victorious in distant lands in the struggle for life with foreign associates But according to the view that all the species of a genus, though distributed to the most remote points of the world are descended from a single progenitor we ought to find and I believe as a general rule we do find that some at least of the species range very widely

We should bear in mind that many genera in all classes are of ancient origin, and the species in this case will have had ample time for dispersal and subsequent modification There is also reason to believe from geological evidence that within each great class the lower organisms change at a slower rate than the higher consequently they will have had a better chance of ranging widely and of still retaining the same specific character This fact together with that of the seeds and eggs of most lowly organised forms being very minute and better fitted for distant transportal probably accounts for a law which has long been observed and which has lately been discussed by Alph de Candolle in regard to plants, namely that the lower any group of organisms stands the more widely it ranges

The relations just discussed —namely lower organisms ranging more widely than the higher —some of the species of widely ranging genera themselves ranging widely —such facts, as Alpine lacustrine and marsh productions being generally related to those which live on the surrounding low lands and dry lands —the striking relationship between the inhabitants of islands and those of the nearest mainland —the still closer relationship of the distinct inhabitants of the islands in the same archipelago —are inexplicable on the ordinary view of the independent creation of each species but are explicab
the nearest
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their new homes

Summary of the last and present Chapters

In these chapters I have endeavoured to show that if we make due allowance for our ignorance of the full effects of changes of climate and of the level of the land which have certainly occurred within the recent period,

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A l w ar led to this co clus n wh ch ı as bee arn ed t by m y t ral t d r th d gn t of gl centres of c eati n, by ar g al co sid t ns, m re c pecially from th importance f barri rs of all ki ds, and from th anal gical d tribut n f ub-g a, g a, and fam l s.

W th re pect to dist n t peci s b l ging t tl sam g us wh h ur th ry b p ad f m parc t sourc f w mak tl sam all wan s as bef re f r gn ance d rem mb th t som f rm f l f l a changed ry l wly n m pe od f t me l vi g bee thus granted fo th m gr t n the d fficult are far from p able th gl this case, as th t f th d d als f tl sam pec s, th y ft n gre t

As mplifying the ffect f cl m tal chang distrib t I h tt mpted to h w h w mporta t p rt th last Glac l period has pl yed wl h ffected n th eq to al reg ns, d wh cl d g tl al t mat f th cold th n th and so th all ed th prod t f ppo t l m

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If th diffi lt b n t us perabl in ad m tting th t in th l g cou se f t m all th ind dual f th am speci s, nd lik w se f th se l pec b l g g to th sam g s, h proceeded from som so rce th all th grand leading facts f geograpl cal d s-

te s, wl th f land w t n t nly sepa t g b t in ppar tly f ming th se eral zool g cal d botan cal pro ces. W an th und rsta d th co ce trat n f re lated pecies within th sam as and how

it tl at und r diff re t lat tudes, f r ta ice ; So th lme ca, tl nl ab tant of tl pla is and m ntains, f tl f rests, marshes, and deserts, are l kcd t tl r n so m ter us a mann i d re l k wise l kcd t tl e t ct b g wl l f rr ly inl ab ted th sar e continent Be ring in mind tl at the n ut l rel t n of ganism t o gan m is of tl e l gl est mpo tance e can se wl y two areas ha g nearly the same pl y cal co l tio s l o ld oft n be nhab t d by ve y d ff rent f rms f l fe f ccording t tl l gth of t m wh ch l as el psed ce tl col ts t red e f tl regi s, r both accord g t tl n t re f tl e co m n cat wh cl

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fied cond t ons f lif —tl re woul l be an a m st endless am t f o ga c act n and actio —and we l uld fi l som gro ps f be gs greatly and som nly l gl tly mod fied—som d l ped n gre t f rce some ist g scanty mbers—an l this w do find in tl se ral gre t geograpl cal pro ces f th w ld

On these same prin ples we ca u l r tand as I h l ired to l w wly oc an lands l ld ha f w d b ta ts, b t that f tl se la g proport l ld be

wh l gro ps f o gan ms, as b trachi ns and t re t l m mmals, l ld b abse t f m ocean l ds, wl l t th m t isol ted s-land l ld posse tl r wn pecul pec f aerial mamm ls b ts. W can see wh in land tl h ld b some r l t b tween th prese ce f mammals, in m re o l ss mod fied co d t n, and th d pth f tl se b tween ch island and the mai land We can clea ly se why ll th nh l tant f an a h pel g th gh pecifically dı t t tl se ral l ts, h ld b l sely related to ach th and h ld lik w se be rel ted b t l ss losely t those f tl are t tin t, o

other source whence immigrants might have been derived We can see why if there exists very closely allied or representative species in two areas however distant from each other some identical species will almost always there be found

As the late Edward Forbes often insisted there is a striking parallelism in the laws of life throughout time and space the laws governing the succession of forms in [illegible] s being [illegible] at the [illegible] areas [illegible] s in many f [illegible] rance of [illegible] ntinuous [illegible] o the rule [illegible] that they may fairly be attributed to our not having as yet discovered in an intermediate deposit certain forms which are absent in it but which occur both above and below so in space it certainly is the general rule that the area inhabited by a single species, or by a group of species is continuous and the exceptions which are not rare may as I have attempted to show be accounted for by former migrations under different circumstances or through occasional means of transport, or by the species having become extinct in the intermediate tracts Both in time and space species and group of [illegible] eir points [illegible] of species, [illegible] or living [illegible] the same area [illegible] in looking to distant provinces throughout the world we find that species in certain classes differ little from each other whilst those in another class or only in a different section of the same order differ greatly from each other In both time and space the lowly organised members of each class generally change less than the highly organised but there are in both cases marked exceptions to the rule According to our theory these several relations throughout time and space are intelligible for whether we look to the allied forms of life which have changed during successive ages or to those which have changed after having migrated into distant quarters in both cases they are connected by the same bond of ordinary generation in both cases the laws of variation have been the same and modifications have been accumulated by the same means of natural selection

CHAPTER XIV

MUTUAL AFFINITIES OF ORGANIC BEINGS MORPHOLOGY EMBRYOLOGY RUDIMENTARY ORGANS

Class fication

From th most rem t period th l t ry f the world rgani being ha been f nd t resembl ach th in desce ding d grees, so that th y can be lassed in gro ps und r gro ps. This class ficat n is n t arb trary lik th gro ping of the tars con t ll t ns. The xist nce f gro p w uld ha bee f mpl r gnificance, if o gro p had bee xcl ly fitted to inhab t th land and an the th w t t feed n flesh, an th r n g tabl matt and so n b t th case is w d ly dif fere t, f t is ton u h w comm nly m m bers f th same ubgro p h diff re t hab ts. I th second and f rth cl pt s, Variat and N tural Select n, I l ttempted to sh w th t withi each co ntry t is th wid ly rang g the mu h d ffused and common, that is th d minant pec s, bel g ing to th larger g nera in ach lass, wh ch ary most Th ari t es, incip t peci s, thus prod ced ultimat ly becom co rted to ew and distin t peci and these n th p inciple f inheritance, tend to prod ce tl w and d minant peci s. Conseq tl th gro p which are n w large, and wl ch g n all incl d many d minant pec es, t nd t g reasing in ize I furth tt mpted t h w th t from th varying desce dants f ach speci trying t occ py as many nd as diff re t places as poss bl in th econ m f nat re, th y constantly t nd to d g n character Thi latt conclus n is ppo ted b observ th gre t d rs ty ff rm wh h, an mall area, com into th cl sest com pet tion, and by certain facts in nat ralisat n, I att mpted also t sh w th t th re is a teady t dency n th f rm whi h re n creas ng in numb and d rging in charac t to pplant and t minat th preced g, l ss d erg nt and l ss mpro ed f rms. I req est th reader to turn t th d gram illus-tratin th acti n, as f rm l xplained f these se al pri cipl and h will see th t th tabl esult is, th t th modified de-scendants proceed g from prog to be-come brok p into gro p bordinat to groups. I th di gram ach l tt n th p-

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in comm n. B t tl e three g n a n u t hand h e, on th same principl mucl n comm n, and f rm a b family disti ct f m that

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tl ree g till farth t tl right hand wl l l ged t an earl pe od. And all

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from ts fam liarity does n t alw ys uffi ci tly t k us is n my j dgm nt th x plained. No d bt o ganic b gs, like all ther objects, can be classed in many w ys, e th r art ficially by ingl charact rs, o m re n tu rally by a numbe f charact rs. We kn w f r nstance, th t m e als and th l m ntal b-tance can be thus arranged In thi ase tl re is of co rse no lat n t g al gi al succes- and n ca an t present be ass gned f th fall g int gro ps. B t w th organic be gs th case d ff re t, d tl vi w abo e gi n accord w th th ir n tural arrangeme t in gro p und gro p and no ther explan ti has er been tt mpted

N tu alists, as w h seen, try t ar ang th pec es, g ra, and famil es in each class, wh t is called th N tural S t m. B t wh t is m ant by this y t m Som th rs look at t m rely as sch m f r arrangi g to-gether th se living objects which are most alike, and for s parating those which are most unlike; or as an art ficial method f en nciating, as br efly as possible, general propositions,—th t is, by sent ce to gi th charac

ters common for instance to all mammal by another those common to all carnivora, by another those common to the dog genus, and then by adding a single sentence a full description is given of each kind of dog The ingenuity and utility of this system are indisputable But many naturalists think that something more is meant by the Natural System they believe that it reveals the plan of the Creator but unless it be specified whether order in time or pace or both or what else is meant by the plan of the Creator it seems to me that nothing is thu added to our knowledge Expressions such as that famous one by Linnæus which we often meet with in a more or less concealed form namely that the characters do not make the genus but that the genus gives the characters seem to imply that some deeper bond is included in our classifications than mere resemblance I believe that this is the case and that community of descent —the one known cause of close similarity in organic beings—is the bond which though observed by various degrees of modification is partially revealed to us by our classifications

Let us now consider the rules followed in classification and the difficulties which are encountered on the view that classification either gives some unknown plan of creation or is imply a scheme for enunciating general propositions and of placing together the forms most like each other It might have been thought (and was in ancient times thought) that those parts of the structure which determined the habits of life and the general place of each being in the economy of nature would be of very high importance in classification Nothing can be more false No one regards the external similarity of a mouse to a shrew of a dugong to a whale of a whale to a fish as of any importance These resemblances though so intimately connected with the whole life of the being are ranked as merely adaptive or analogical characters but to the consideration of these resemblances we shall recur It may even be given as a general rule that the less any part of the organisation is concerned with special habits the more important it becomes for

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lated to the habits and food of an animal I have always regarded as affording very clear indications of its true affinities We are least likely in the modifications of these organs to mistake a merely adaptive for an essential character With plants how remarkable it is that the organs of vegetation, on which their nutrition and life depend are of little significance whereas the organs of reproduction, with their product the seed and embryo, are of paramount importance! So again in formerly discussing certain morphological characters which are not functionally important, we have seen that they are often of the highest service in classification This depends on their constancy throughout many allied groups and their constancy chiefly depends on any slight deviations not having been preserved and accumulated by natural selection which acts only on serviceable characters

That the mere physiological importance of an organ does not determine its classificatory value is almost proved by the fact that in allied groups in which the same organ as we have every reason to suppose has nearly the same physiological value its classificatory value is widely different. No naturalist can have worked long at any group without being struck with this fact and it has been fully acknowledged in the writings of almost every author It will suffice to quote the highest authority Robert Brown who in speaking of certain organs in the Proteaceæ says their generic importance like that of all their parts,

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other work he says, the genera of the Connaraceæ differ in having one or more ovaria, in the existence or absence of albumen in the imbricate or valvular æstivation. Any one of these characters singly is frequently of more than generic importance though here even when all taken together they appear insufficient to separate *Cnestis* from *Connarus* To give an example amongst insects in one great division of the Hymenoptera the antennæ, as Westwood has remarked are most constant in structure in another division they differ much and the differences are of quite subordinate value in classification yet no one will say that the antennæ in these two divisions of the same order are of unequal physiological importance. Any number of instances could be given of the varying importance for classification of the same important organ within the same group of beings

Again, no one will say that rudimentary or atrophied organs are of high physiological or vital importance yet, undoubtedly organs in this condition are often of much value in clas-

generation. No one will dispute that the rudimentary teeth in the upper jaws of young ruminants, and certain rudimentary bones of the leg, are highly serviceable in exhibiting the close affinity between ruminants and pachyderms. Robert Brown has strongly insisted on the fact that the position of the rudimentary florets is of the highest importance in the classification of the grasses.

Numerous instances could be given of characters derived from parts which must be considered of very trifling physiological importance, but which are universally admitted as highly serviceable in the definition of whole groups. For instance, whether or not there is an open passage from the nostrils to the mouth, the only character, according to Owen, which absolutely distinguishes fishes and reptiles—the inflection of the angle of the lower jaw in marsupials—the manner in which the wings of insects are folded—mere colour in certain Algæ—mere pubescence on parts of the flower in grasses—the nature of the dermal covering, as hair or feathers, in the Vertebrata. If the Ornithorhynchus had been covered with feathers instead of hair, this external and trifling character would have been considered by naturalists as an important aid in determining the degree of affinity of this strange creature to birds.

The importance, for classification, of trifling characters, mainly depends on their being correlated with many other characters of more or less importance. The value indeed of an aggregate of characters is very evident in natural history. Hence, as has often been remarked, a species may depart from its allies in several characters, both of high physiological importance, and of almost universal prevalence, and yet leave us in no doubt where it should be ranked. Hence, also, it has been found that a classification founded on any single character, however important that may be, has always failed; for no part of the organisation is invariably constant. The importance of an aggregate of characters, even when none are important, alone explains the aphorism enunciated by Linnæus, namely, that the characters do not give the genus, but the genus gives the characters; for this seems founded on the appreciation of many trifling points of resemblance, too slight to be defined. Certain plants, belonging to the Malpighiaceæ, bear perfect and degraded flowers; in the latter, as A. de Jussieu has remarked, "The greater number of the characters proper to the species, to the genus, to the family, to the class, disappear, and

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points of

ord yet M. Richard sagaciously saw, as Jussieu observes, that this genus should still be retained amongst the Malpighiaceæ. This case well illustrates the spirit of our classifications.

Practically, when naturalists are at work, they do not trouble themselves about the physiological value of the characters which they use in defining a group or in allocating any particular species. If they find a character nearly uniform, and common to a great number of forms, and not common to others, they use it as one of high value; if common to some lesser number, they use it as of subordinate value. This principle has been broadly confessed by some naturalists to be the true one; and by none more clearly than by that excellent botanist, Aug. St. Hilaire. If several trifling characters are always found in combination, though no apparent bond of connection can be discovered between them, especial value is set on them. As in most groups of animals, important organs, such as those for propelling the blood, or for aerating it, or those for propagating the race, are found nearly uniform, they are considered as highly serviceable in classification; but in some groups all these, the most important vital organs, are found to offer characters of quite subordinate value. Thus, as Fritz Müller has lately remarked, in the same group of crustaceans, Cypridina is furnished with a heart, whilst in two closely allied genera, namely Cypris and Cytherea, there is no such organ; one species of Cypridina has well-developed branchiæ, whilst another species is destitute of them.

We can see why characters derived from the embryo should be of equal importance with those derived from the adult, for a natural classification of course includes all ages. But it is by no means obvious, on the ordinary view, why the structure of the embryo should be more important for this purpose than that of the adult, which alone plays its full part in the economy of nature. Yet it has been strongly urged by those great naturalists, Milne Edwards and Agassiz, that embryological characters are the most important of all; and this doctrine has very generally been admitted as true. Nevertheless, their importance has sometimes been exaggerated, owing to the adaptive

characters of larvæ not having been excluded in order to show this Fritz Muller arranged by the aid of such characters alone the great class of crustaceans and the arrangement did not prove a natural one But there can be no doubt that embryonic excluding larval characters are of the highest value for classification not only with animals but with plants Thus the main divisions of flowering plants are founded on differences in the embryo —on the number and position of the cotyledons and on the mode of development of the plumule and radicle We shall immediately see why these characters possess so high a value in classification namely from the natural system being genealogical in its arrangement

Our classifications are often plainly influenced by chains of affinities Nothing can be easier than to define a number of characters common to all birds but with crustaceans any such definition has hitherto been found impossible There are crustaceans at the opposite ends of the series which have hardly a character in common yet the species at both ends from being plainly allied to others and these to others and so onwards can be recognised as unequivocally belonging to this and to no other class of the Articulata

Geographical distribution has often been used though perhaps not quite logically in classification more especially in very large groups of closely allied forms Temminck insists on the utility or even necessity of this practice in certain groups of birds and it has been followed by several entomologists and botanists

Finally with respect to the comparative value of the various groups of species such as orders sub-orders families sub families and genera, they seem to be at least at present, almost arbitrary Several of the best botanists such as Mr Bentham and others have strongly insisted on their arbitrary value Instances could be given among t plants and insects of a group first ranked by practised naturalists as only a genus, and then raised to the rank of a sub family or family and this has been done, not because further research has detected important structural differences at first overlooked but because numerous allied species with slightly different grades of difference have been subsequently discovered

All the foregoing rules and aids and difficulties in classification may be explained if I do not greatly deceive myself on the view that the Natural System is founded on descent with modification —that the characters which naturalists consider as showing true affinity between any two or more species, are those which have been inherited from a common parent all true classification being genealogical —that community of descent is the hidden bond which naturalists have been unconsciously seeking and not some unknown plan of creation or the enunciation of general propositions and the mere putting together and separating objects more or less alike

But I must explain my meaning more fully I believe that the *arrangement* of the groups within each class in due subordination and relation to each other must be strictly genealogical in order to be natural but that the *amount* of difference in the several branches or groups though allied in the same degree in blood to their common progenitor may differ greatly being due to the different degrees of modification which they have undergone and this is expressed by the forms being ranked under different genera, families sections, or orders The reader will best understand what is meant if he will take the trouble to refer to the diagram in the fourth chapter We will suppose the letters A to L [illegible]

[illegible] genera (A F and I) a species has transmitted modified descendants to the present day represented by the fifteen genera (a^{14} to [illegible]) on the uppermost horizontal line. Now all these modified descendants from a single species are related in blood or descent in the same degree they may metaphorically be called cousins to the same millionth degree yet they differ widely and in different degrees from each other The forms descended from A now broken up into two or three families, constitute a distinct order from those descended from I also broken up into two families. Nor can the existing species descended from A be ranked in the same genus with the parent A or those from I with the parent I But the existing genus F^{14} may be supposed to have been but slightly modified and it will then rank with the parent genus F just as some few still living organisms belong to Silurian genera. So that the comparative value of the differences between these organic beings which are all related to each other in the same degree in blood has come to be widely different. Nevertheless their genealogical *arrangement* remains strictly true not only at the present time but at each successive period of descent.

All the modified descendants from A will have inherited something in common from th ir common parent, as will ll th descendants from I so will t be with each ubordinate branch of descendants, t each success ve stage. If how ver w suppose any descendant of A, or of I to ha e become so much modified as t ha e lost *all traces f ts parentage in* t is case, ts place in th natural t m will be lost, as seems to ha occurred with som f w existing rganisms. All th descendants f the genus F along ts wh le lin of descent, are supposed to ha been b t littl modified, and they form single ge us. B t this g nus, though much isolated, will till occup t proper intermediate position. Th representation f the groups, as here given in th diagram on a flat surface is much too simple. Th branches ought t have di rged *in all directions*. If the names of the gro ps had been simply written down in a linear series, th representation would ha been still less natural and t is notoriously not possible to represent in series, on flat surface th affinities which we disco er in nature amongst the beings of th same group. Thus, th N tural System is genealogical in ts arrangem nt, like a pedigree b t the *amount* of modification which th *different* groups have und rgon has t be expressed by ranking them under different so-called gen ra, sub-families, families, sections, ord rs, and classes.

It may be worth while t illustrat this ew of classification, b taking the case of languages. If w possessed perfect ped gree of mankind, a genealogical arrangem nt of th races of man would aff rd th best classification of th arious languages now spok n througho t th world and if all extinct languages, and all intermediat and slowl chan ing dialects w re t be included such an arrangement would be the onl possibl one. Yet t might be that som ancient languages had altered very l ttle and had gi n rise t few new languages, whilst others had altered much wing to the spreading, isolation, and state of civilisation of th se ral co-descended races, and had thus gi en rise t man n w dialects and languages. Th arious d grees of difference between th languages of the sam stock, would have to be expressed by groups subordinate to groups b t th prope or en th only possibl arrangement w uld still be genealogical and this would be trictly natural, as t would connect tog the all languages, extinct and recent, by the closest affinities, and would gi th filiation and rigin of each tongu

In confirmation of this view let us glance at the classification f varieties, which are known bel eved t be descended from a ngl pecies. These are gro ped und the species, with th b- arieties und r th rieties and in som cases, as with th d mestic p geon, with several th grad s f diff re ce Nearly the sam rules are followed as in classif in species. Authors h ve insisted on th necessity of arranging arieties n natural instead of an artificial t m w are ca tioned for n tance not t class two ari t es of th pineapple t geth r m rel because th ir fru t, th ugh th most mportant part, happens to be nearly id ntical no o p ts th Swedish and common turnip t geth though the escu lent and thick ed t ms are so similar What ever part is f und to be most constant, is used in classin ari ties thus the gre t gricultur ist Marshall says the h rns are very useful for this purpose w th cattle because the are less variabl than the shape colour of the body &c. wh reas with sheep the horns are much less serviceable because less constant. In classing ari ties, I apprehend that if w had a real pedigree a genealogical lassification would be uni rsally pref rred and t has been att mpted in some cases. For w might feel sure, wheth th re had been more or less modification, that the *principle of nh ritance* w uld keep the forms tog th which were allied in the gre test numbe of points. In tumbler pi eons, though som of th sub- arieties differ in th mporta t charact of th length of th beak, y t all are k pt togeth r from ha ing th comm hab t of tumbling b t th short-faced breed has nearly o quit lost this hab t n verth less, w th ut any thought on th ubject, these tumbl rs are kept in the sam gro p, because allied in blood and alike in som the respects.

W th species in a stat of nature ry naturalist has in fact brought descent into his classification for h includes in his lowest grad that of species, th two sexes and how enormousl these som times differ in th most important characters, is known to ev ry nat ralist scarcel single fact can be predicated in common of th adult males and hermaphrodites of certain cirripedes, and t no one dreams of separating th m. As soon as th three orchid an f rms, Monachanthus, Myanthus, and Catasetum, which had previously been ranked as three distinct gen ra, were

known to be sometimes produced on the same plant they were immediately considered as varieties and now I have been able to show that they are the male female and hermaphrodite forms of the same species The naturalist includes as one species the various larval stages of the same individual however much they may differ from each other and from the adult as well as the so-called alternate generations of Steenstrup which can only in a technical sense be considered as the same individual He includes monsters and varieties not from their partial resemblance to the parent form but because they are descended from it

As descent has universally been used in classing together the individuals of the same species though the males and females and larvæ are sometimes extremely different and as it has been used in classing varieties which have undergone a certain and sometimes a considerable amount of modification may not this same element of descent have been unconciously used in grouping species under genera and genera under higher groups all under the so-called natural system? I believe it has been unconsciously used and thus only can I understand the several rules and guides which have been followed by our best systematists As we have no written pedigrees we are forced to trace community of descent by resemblances of any kind Therefore we chose those character which are the least likely to have been modified in relation to the conditions of life to which each species has been recently exposed Rudimentary structures on this view are as good as or even better than other parts of the organisation We care not how trifling a character may be—let it be the mere inflection of the angle of the jaw the manner in which an insect s wing is folded whether the skin be covered by hair or feathers—if it prevail throughout many and different species, especially those having very different habits of life it assume high value for we can account for its presence in so many forms with such different habits only by inheritance from a common parent We may err in this respect in regard to single points of structure but when several characters let them be ever so trifling concur throughout a large group of beings having different habits we may feel almost sure on the theory of descent that these characters have been inherited from a common ancestor and we know that such aggregated characters have especial value in classification

We can understand why a species or a group of species may depart from its allies in several of its most important characteristics and yet be safely classed with them This may be safely done and is often done as long as a sufficient number of characters let them be ever so unimportant betrays the hidden bond of community of descent Let two forms have not a single character in common yet if these extreme forms are connected together by a chain of intermediate groups we may at once infer their community of descent, and we put them all into the same class As we find organs of high physiological importance—those which serve to preserve life under the most diverse conditions of existence—are generally the most constant we attach especial value to them but if these same organs in another group or section of a group are found to differ much we at once value them less in our classification We shall presently see why embryological characters are of such high class fica

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from the same parents

Analogical Resemblances —We can understand on the above views the very important distinction between real affinities and analogical or adaptive resemblances Lamarck first called attention to this subject and he has been ably followed by Macleay and others The resemblance in the shape of the body and in the fin like anterior limbs between dugongs and whales and between these two orders of mammals and fishes are analogical So is the resemblance between a mouse and a shrew mouse (Sorex) which belong to different orders and the still closer resemblance insisted on by Mr Mivart betwe n the mouse and a small mar upial animal (Antechinus) of Australia These latter resemblances may be accounted for as it seems to me by adaptation for similarly active movements through thickets and herbage together with concealment from enemies

Amongst insects there are innumerable similar instances thus Linnæus misled by external appearances actually classed an homopterous insect as a moth We see something of the same kind even with our dome tic varietie as in the strikingly similar shape of the body in the improved breeds of the Chinese and common pig which are descended from distinct species and in the similarly thickened stems of the

commo and specifically d tinct Swedish turnip Th resemblance between the grey hound and th raceh rse s hardly more fanci ful than the analogi which ha e been d wn by som a th s between w d ly d ff rent animals

O the vi w f charact rs b ing of re l m portance fo classificat on, only n so far as they re al desc t, w can l arly u d rstand why anal gical or ad pti characters al th gh f th tm t mportance to th w lfare of the being are alm t al less t th ys-tematist. F r animals, b lo g g to t o most distinct lin f d scent, may ha e becom adapted to similar conditi ns, and thu h ass med a cl se xt rn l resemblance but h resemblances will n t r al—will ath te d to conceal the blood rel tionsh p W can th under tand th appare t p radox that th v ry same haract rs ar analog cal when gro p comp red w th an tl b t gi e tru affinit wh th m mbe of th sam group are compared tog th th s, th h pe f th body and fi lik l mb are nly analogical wh n whal are compared with fishes, being ad ptat in both classe f r wimming th gh th w te b t bet een the se al m mb rs f th whal family the sh pe f th body and th fi lik l mb ff ch acters xh b ting tru affinity f r as th se parts are so arly imilar thro gl t th whol family w cann t d bt that th y h e bee inh rited from comm ancesto So t is w th fi h

Num rous cases co ld b gi n f trik g

nimals wh ch ar w d ly und ed n th tural y t m B t tl resembl nce s co

ppe y w f ur p m lars and ly tw m lars h lst th Thylac has thre p m lar d f m lars. Th m lars also d ff m ch th t anim ls rel ti and tru t re Th adult d t t p eceded by a w d ly d ff ent m lk de tit n. Any e m y f cour deny that th teeth in th case h be n ad pted f tearing flesh thro gh th tural selectio f ccessi ariat ns b t f thi b admitted in th ase t s int ll g bl to

me that t sh uld b den ed in the otl er I am glad to find that so high an uth r ty as I rofe sor Flower has come to this same n clu n.

The e traord nary cases g n in a forme ch pte f wid ly diff rent fishes possess g electr c o gans,—of w dely d fferent insects possess g lum n u o gans,—a d of rel ds and ascl piad ha ing pollen masse will s- ed d come nde thi same head f ana- l

ca es some f damental diff rence u g o tl or d l pm t of the parts, and g n rally in the r matured tructure can b d tected Th d g ned is the sam b t tl means, th ugh ppearing s perfi ially to be the me re essent ally d ff rent. The pr cipl f m rly alluded to u der tl e t m f l gi l nation has probably in tl se

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tances,—to nhab t, fo instance the three l ments f land and w t —we can pe hap u d rstand h w t s th t a num rical par ll l m has som t m b n bserved b twee th b g p f d tin t classes. A naturalist, struck w th a parallelism f th nature by arb trarily rai ing or ink g th al f th gro ps n sev ral classe (and all ou xpe nce sh w th t th al t on as y t rb t ary) could eas ly tend tl paral lelism e w d ang and th th septen ary q inary quart rnary and ternary clas-ficat ns ha probably arisen

Th an th and n lass f cas s n wh ch l se t rnal esemblance d es t d pe d n ad ptati n to m lar hab ts f l f b t has been gained for th sake f protect n I all d to th w d rf l mann r in wh h certain b tterfli m tat as first desc b d by Mr B t s, th and quit distinct pe This cell t observ has hown th t in som dist icts f S Am ca, wh re f instance an

Ithomia abounds in gaudy swarms another butterfly namely a Leptalis, is often found mingled in the same flock and the latter so closely resembles the Ithomia in every shade and stripe of colour and even in the shape of its wings that Mr Bates with his eyes sharpened by collecting during eleven years was though always on his guard continually deceived When the mockers and the mocked are caught and compared they are found to be very different in essential structure and to belong not only to distinct genera but often to distinct families Had this mimicry occurred in

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imitates an Ithomia another mocking and mocked species belonging to the same two genera equally close in their resemblance may be found Altogether no less than ten genera are enumerated which include species that imitate other butterflies The mockers and mocked always inhabit the same region we never find an imitator living remote from the form which it imitates The mockers are almost invariably rare insects the mocked in almost every case abound in swarms In the same district in which a species of Leptalis closely imitates an Ithomia there are sometimes other Lepidoptera mimicking the same Ithomia so that in the same place species of three genera of butterflies and even a moth are found all closely resembling a butterfly belonging to a fourth genus It deserves especial notice that many of the mimicking forms of the Leptalis, as well as of the mimicked forms, can be shown by a graduated series to be merely varieties of the same species whilst others are undoubtedly distinct species But why it may be asked are certain forms treated as the mimicked and others as the mimickers? Mr Bates satisfactorily answers this question by showing that the form which is imitated keeps the usual dress of the group to which it belongs whilst the counterfeiters have changed their dress and do not resemble their nearest allies

We are next led to inquire what reason can be assigned for certain butterflies and moths so often assuming the dress of another and quite distinct form why to the perplexity of naturalists has nature condescended to the tricks of the stage? Mr Bates has, no doubt, hit on the true explanation The mocked form which always abound in numbers must habitually escape destruction to a large extent otherwise they could not exist in such swarms and a large amount of evidence has now been collected showing that they are distasteful to birds and other insect-devouring animals The mocking forms, on the other hand that inhabit the same district are comparatively rare and belong to rare groups hence they must suffer habitually from some danger for otherwise from the number of eggs laid by all butterflies, they would in three or four generations swarm over the whole country Now if a member of one of these persecuted and rare groups were to assume a dress so like that of a well-protected species that it continually deceived the practised eye of an entomologist, it would often deceive predaceous birds and insect

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so closely to resemble the mimicked for he found that some of the forms of Leptalis which mimic so many other butterflies varied in an extreme degree In one district several varieties occurred and of these one alone resembled to a certain extent the common Ithomia of the same district In another district there were two or three varieties one of which was much commoner than the others and this closely mocked another form of Ithomia. From facts of this nature Mr Bates concludes that the Leptalis first varies and when a variety happens to resemble in some degree any common

and insect, and is consequently oftener pre-

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pelago and Africa and with some other insects. Mr Wallace has also detected one such case with birds but we have none with the larger quadrupeds The much greater frequency of imitation with insects than with other animals, is probably the consequence of their small size insects cannot defend themselves, excepting indeed the kinds furnished with a sting and I have never heard of an instance of such kinds mocking other insects though they are mocked insects cannot easily escape by flight from the

larger animals which prey on them: therefore speaking metaphorically they are reduced, like most weak creatures, to trickery and dissimulation.

It should be observed that the process of imitation probably never commenced between forms widely dissimilar in colour. But starting with species already somewhat like each other the closest resemblance, if beneficial, could readily be gained by the above means, and if the imitated form was subsequently and gradually modified through any agency the imitating form would be led along the same track, and thus be altered to almost any extent, so that it might ultimately assume an appearance or colouring wholly unlike that of the other members of the family to which it belonged. There is, however some difficulty on this head, for it is necessary to suppose in some cases that ancient members belonging to several distinct groups, before they had diverged to their present extent, accidentally resembled a member of another and protected group in a sufficient degree to afford some slight protection, this having given the basis for the subsequent acquisition of the most perfect resemblance.

On the Nature of the Affinities connecting Organic Beings.—As the modified descendants of dominant species, belonging to the larger genera, tend to inherit the advantages which made the groups to which they belong large and their parents dominant, they are almost sure to spread widely, and to seize on more and more places in the economy of nature. The larger and more dominant groups within each class thus tend to go on increasing in size; and they consequently supplant many smaller and feebler groups. Thus we can account for the fact that all organisms, recent and extinct, are included under a few great orders, and under still fewer classes. As showing how few the higher groups are in number, and how widely they are spread throughout the world, the fact is striking that the discovery of Australia has not added an insect belonging to a new class; and that in the vegetable kingdom, as I learn from Dr. Hooker, it has added only two or three families of small size.

In the chapter on Geological Succession I attempted to show, on the principle of each group having generally diverged much in character during the long-continued process of modification, how it is that the more ancient forms of life often present characters in some degree intermediate between existing groups. As some few of the old and intermediate forms have transmitted to the present day descendants but little modified, these constitute our so-called osculant or aberrant species. The more aberrant any form is, the greater must be the number of connecting forms which have been exterminated and utterly lost. And we have some evidence of aberrant groups having suffered severely from extinction, for they are almost always represented by extremely few species; and such species as do occur are generally very distinct from each other, which again implies extinction. The genera Ornithorhynchus and Lepidosiren, for example, would not have been less aberrant had each been represented by a dozen species, instead of as at present by a single one, or by two or three. We can, I think, account for this fact only by looking at aberrant groups as forms which have been conquered by more successful competitors, with a few members still preserved under unusually favourable conditions.

Mr. Waterhouse has remarked that, when a member belonging to one group of animals exhibits an affinity to a quite distinct group, this affinity in most cases is general and not special: thus, according to Mr. Waterhouse, of all rodents, the bizcacha is most nearly related to marsupials; but in the points in which it approaches this order, its relations are general, that is, not to any one marsupial species more than to another. As these points of affinity are believed to be real and not merely adaptive, they must be due in accordance with our view to inheritance from a common progenitor. Therefore we must suppose either that all rodents, including the bizcacha, branched off from some ancient marsupial, which will naturally have been more or less intermediate in character with respect to all existing marsupials; or that both rodents and marsupials branched off from a common progenitor, and that both groups have since undergone much modification in divergent directions. On either view we must suppose that the bizcacha has retained, by inheritance, more of the characters of its ancient progenitor than have other rodents; and therefore it will not be specially related to any one existing marsupial, but indirectly to all or nearly all marsupials, from having partially retained the character of their common progenitor, or of some early member of the group. On the other hand, of all marsupials, as Mr. Waterhouse has remarked, the Phascolomys resembles most nearly, not any one species, but the general order of rodents. In this case, however, it may

Ithomia abounds in gaudy swarms another butterfly namely a Leptalis, is often found mingled in the same flock and the latter so closely resembles the Ithomia in every shade and stripe of colour and even in the shape of its wings that Mr Bates with his eyes sharpened by collecting during eleven years was though always on his guard continually deceived When the mockers and the mocked are caught and compared they are found to be very diff [illegible] and to [illegible] ten to [illegible] red in [illegible] or two instances it might have been passed over as a strange coincidence But if we proceed from a district where one Leptalis imitates an Ithomia another mocking and mocked species, belonging to the same two genera equally close in their resemblance may be found Altogether no less than ten genera are enumerated which include species that imitate other butterflies The mockers and mocked always inhabit the same region we never find an imitator living remote from the form which it imitates The mockers are almost invariably rare insects the mocked in almost every case abound in swarms In the same district in which a species of Leptalis closely imitates an Ithomia [illegible]

[illegible] resembling a butterfly belonging to a fourth genus It deserves especial notice that many of the mimicking forms of the Leptalis as well as of the mimicked forms can be shown by a graduated series to be merely varieties of the same species whilst others are undoubtedly distinct species But why it may be asked are certain forms treated as the mimicked and others as the mimickers? Mr Bates satisfactorily answers this question by showing that the form which is imitated keeps the usual dress of the group to which it belongs whilst the counterfeiters have changed their dress and do not resemble their nearest allies

We are next led to inquire what reason can be assigned for certain butterflies and moths so often assuming the dress of another and quite distinct form why to the perplexity of naturalists has nature condescended to the tricks of the stage? Mr Bates has no doubt, hit on the true explanation The mocked forms which always abound in numbers must habitually escape destruction to a large extent otherwise they could not exist in such swarms and a large amount of evidence has now been collected showing that they are distasteful to birds and other insect-devouring animal The mocking forms, on the other hand that inhabit the same district, are comparatively rare and belong to rare groups hence they must suffer habitually from some danger for otherwise from the number of eggs laid by all butterflies they would in three or four generations swarm over the whole country Now if a member of one of these perse[illegible]

[illegible] sed eye of an entomologist, it would often deceive predaceous birds [illegible]

[illegible] y to resemble the mimicked for he found that some of the forms of Leptalis which mimic so many other butterflies varied in an extreme degree In one district several varieties occurred and of these one alone resembled to a certain extent the common Ithomia of the same district In another district there were two or three varieties one of which was much commoner than the others and this closely mocked another form of Ithomia. From facts of this nature Mr Bates concludes that the Leptalis first varies and when a variety happens to resemble in some degree any common butterfly inhabiting the same district, this variety from its resemblance to a flourishing and little persecuted kind has a better chance of escaping destruction from predaceous birds and insects and is consequently oftener preserved — the less perfect degrees of resemblance being generation after generation eliminated and only the others left to propagate their kind So that here we have an excellent illustration of natural selection

Messrs Wallace and Trimen have likewise described several equally striking cases of imitation in the Lepidoptera of the Malay Archipelago and Africa and with some other insects Mr Wallace has also detected one such case with birds but we have none with the larger quadrupeds The much greater frequency of imitation with insects than with other animals is probably the consequence of their small size insects cannot defend themselves excepting indeed the kinds furnished with a sting and I have never heard of an [illegible]

perfected, gen alogical un t ar angem nt th the grades of d ff rence e pressed l y the t rms ge ra, families, ord rs, & w can un derstand th rules which we are con pelled to follow in our lassifi tion. We an und rstand hy w al e certain resemblances far more than oth rs wl y w se rud m nt rs an l useless organs, or oth rs of trifli g physiologi al mportance why in finding th rel tions bet en one group and anoth r we mmarily reject analogical or ad pt e cl aract rs, and vet use these same charact rs w th tl l m ts of th sam gro p. W can learl see l w t that all h m and e tin t forms can be grou ped togeth r w thin a f gre t classe and l the se ral m mbers of each la re con

iew and — of re tion, e may hope t make sure b t slow progress.

Prof ssor Haeckel in his *Generelle Morphologie* and in oth w ks, has recently bro gl t his gre t kn ledg and abil ties to bear on hat h calls phylogeny o the lin of descent of all organ beings. In drawing p tl se ral se ie h t usts chiefly to mbryolog al charact rs, b t rece aid from h m l ous and rud m tary organs, as w ll as from th ucessi periods t which the arious forms of lif are belie ed t ha e first ppeared in ur geological formations. H has thus boldl mad great beginning, and sh u l w classificat will in th f t re be tre ted

M phology

W ha seen that th m mbers of th sam lass, ind pe d ntl f th ir hab t f l f resembl ach oth th g n ral plan of th rganisatio Th resemblance is ft n expressed b th t rm ty of t pe o by sa ing that tl se ral part and organs in the diff re t pec es f the lass are l m logous. The h le bject is ncl ded und th ge ral t n f M rph logy Th is of the most t re t g d partm nt f natural history and ma almost be said t be t ry so l Wh t an be m re uri us than th t tl hand f man, f rmed for gra pin g that f mol f digging th l g f th l rse th padll f tl porpoise and the wing of the bat, sh ld all be con tructed n tl sam patt rn and should nclud sim lar bo s, th sam

relat ve position H w curiou it is, to gi e a bordinat tl ough triking instance th t tl h nd f et of the kangaroo, wl icl are so ll w pl ins —

eatin band coots, — ar u t use — rsupials, — would all be on

the same skin, so that tl ey appear as toe furn isl ed w th two claws. N tw th tand ng this similarity of patt n, it s ob us that tl e l ind feet f these se eral an mals are used for as w d ly different p rposes as t p ssibl t conce e Tl e ase s rendered all tl e re triking by the Am rican oposs ms, wl ich f llow n arl the same hab ts of l f as some of th ir Au tral an relati es, ha ing f et constru ted n tl e ord nary plan Professor Fl w from wh m these tatem nts are tak n, remarks in conclusion We ma call this con f t to t pe w thout getting mu h n arer

Geoffroy St. H laire l as trongly n ted on th h gl importance of rel t e po t on or connectio in hom l o parts the may diff to almost an t nt i f rm and ize and y t remain con et d togetl r tl san e in ariabl rd r We n r find for tan e th bon of th rm and fore-arm r of tl e tl gh and leg tran posed H ce tl san names can be gi en t tl l m logo bo in w d ly d ff rent animals. W see tl e san great l w the constr t on of th m ths of

organs, serving f r u l w d ly d ff r t purposes, are f med b fin t l n m ro s modificat ns of an upper l p, mand bles, and t o pairs f max llæ Tl sa l w g n tl con tru t n f tl n th d l mb f taceans. So t w tl th tl rs f plart N th g can b m re l peless tl an t t t mpt t plain tl is m larity f patte n m mbers of tl e sam class, by t l t o by tl doctri f fi al s. Th l pel ss ss of th tt mpt has been pressly adm tted by Ow n n l m st t re ting rk on the N

be strongly suspected that the resemblance is only analogical owing to the Phascolomys having become adapted to habits like those of a rodent The elder De Candolle has made nearly similar observations on the general nature of the affinities of distinct families of plants

On the principle of the multiplication and gradual divergence in character of the species descended from a common progenitor together with their retention by inheritance of some characters in common we can understand the excessively complex and radiating

now broken up by extinction into distinct groups and sub groups will have transmitted some of its characters modified in various ways and degrees to all the species and they will consequently be related to each other by circuitous lines of affinity of various lengths (as may be seen in the diagrams so often referred to) mounting up through many predecessors As it is difficult to show the blood relationship between the numerous kindred of any ancient and noble family even by the aid of a genealogical tree and almost impossible to do so without this aid we can understand the extraordinary difficulty which naturalists have experienced in describing without the aid of a diagram the various affinities which they perceive between the many living and extinct members of the same great natural class

Extinction as we have seen in the fourth chapter has played an important part in defining and widening the intervals between the several groups in each class We may thus account for the distinctness of whole classes from each other—for instance of birds from all other vertebrate animals—by the belief that many ancient forms of life have been utterly lost through which the early progenitors of birds were formerly connected with the early progenitors of the other and at that time less differentiated vertebrate classes There has been much less extinction of the forms of life which once connected fishes with batrachians There has been still less within some whole classes, for instance the Crustacea, for here the most wonderfully diverse forms are still linked together by a long and only partially broken chain of affinities Extinction has only defined the groups it has by no means made them for if every form which has ever lived on this earth were suddenly to reappear though it would be quite impossible to give definitions by which each group could be distinguished still a natural classification or at least a natural arrangement would be possible We shall see this by turning to the diagram the letters, A to *L* may represent eleven Silurian genera, some of which have produced large groups of modified descendants with every link in each branch and sub branch still alive and the links not greater than those between existing varieties In this case it would be quite impossible to give definitions by which the several members of the several groups could be distinguished from their more immediate parents and descendants Yet the arrangement in the diagram would still hold good and would be natural for on the principle of inheritance all the forms descended for instance from A would have something in common In a tree we can distinguish this or that branch though at the actual fork the two unite and blend together We could not as I have said define the several groups but we could pick out types or forms, representing most of the characters of each group whether large or small and thus give a general idea of the value of the differences between them This is what we should be driven to if we were ever to succeed in collecting all the forms in any one class which have lived throughout all time and space Assuredly we shall never succeed in making so perfect a collection nevertheless, in certain classes we are tending towards this end and Milne Edwards has lately insisted in an able paper on the high importance of looking to types whether or not we can separate and define the groups to which such types belong

Finally we have seen that natural selection which follows from the struggle for existence and which almost inevitably leads to extinction and divergence of character in the descendants from any one parent species explains that great and universal feature in the affinities of all organic beings namely their subordination in group under group We use the element of descent in classing the individuals of both sexes and of all ages under one species, although they may have but few characters in common we use descent in classing acknowledged varieties however different they may be from their parents and I believe that this element of descent is the hidden bond of connection which naturalists have sought under the term of the Natural System On this idea of the natural system being in so far as it has been

brata probably possessed many v rtebræ the unkn wn prog nit r f th Art culata, many segm ts and th unknown p ogenit r f flowering plants, many l es arranged in ne or more sp res. W ha e also f rm ly seen that parts man times repeated are mm ntly liable t arr not nly in n mber b t i form C nseq tly such parts, be g lread p esent in consid rabl umbers, and being highly ariable, w ld naturally aff d th mat rials for adaptati t th most diff t purposes t the w ld g n rally r tain, thr gh th *force of inheritance*, plain tr ces f their original or f dam tal resemblance. They would retain this resemblance all th m re, as th ariations, which aff rded th basis for their subseq t modificati thro gh nat ural selecti n, w ld t d from th first t be similar the parts being t an arly tag f gro th alike and being bjected t nearly th sam co d t ns. S ch parts, wh the m re or less modified, unless th ir comm n or gin becam wh lly obsc red, w uld be serially h m l go s.

In th great class of m ll scs, th ugh th parts in disti ct species can be h wn to be homologous, ly f w serial h m l ries, s ch as th al es f chitons, can be dicated that is, w are seld m nabled t say that part is h m l g us with an ther part in th sam individual. And w can u d rstand this fact f in m lluscs, n in the l west mem bers f th lass, w d n t find n arly so m ch indefinit repetition f any part as w find in th th great classes f th animal and getabl kingd ms.

B t m rph l gy is a m ch more complex subject than t t first ppears, as has lately bee w ll sh wn in remarkabl pape by Mr E. Ra Lankester wh has drawn an im

distinct animals ing to th ir descent from a comm pro nito with subseq ent modificatio *homogenous* and th resemblances which cannot th be accounted f h proposes to call *homoplastic* F instance h belie es that th hearts f b ds and mammals are as whole hom g us,—that is, ha been de*ri ed from* comm n prog nito b t that the four ca ties f th heart in the tw lasses are homoplastic,—that is, ha been independ tl d loped. Mr Lankester also add ces the lose resemblance f the parts n th right and left des of t e body and in the successi e f h m ndivid al animal and

mperfect mann r as anal gou mou ... s o resemblances. The r formati n may be at trib ted in part to distinct rganisms, or t dist f th same organism, h n

as

sin

f

wl

Naturalists frequently peak o ... f rmed f metam rph sed ertebræ th j w of crabs as m tam rphosed *legs* the tam n and pistils in fl w rs as m tamorphosed l a b t t w uld in m t case be m re correct as Professo Huxley has remarked, to peak f both skull and rtebræ j s and legs, &c. as ha ing been m tam rph sed not on from tl e oth as they n w xist, b t from some com *mon and mpl r l m nt.* Most n turalists, h w use such langu g only in a m ta ph rical sense th y are far from m aning tl t

v rted in ...

ppearance of this having occurred tl t naturalists can hardl a d mpl yi g lan gu g h ing this plain gnificati n. According to th w he maintained, such l n guage may be used lite ally and the w d rful fact of th j ws, f r instance of crab retai ing num rous characters wh ch they prob bl w uld ha retained through inh ritance f th y had really been m tamorphosed from tru th gh trem ly *simple* l gs, is n part explained.

Development and Embryology

This is o f th most important subjects in th whol round f hi tory Th metam rphoses f insects, with wh ch ty o is familiar are g rally effected abruptly by a few stages but th transf rmations are in reality *num rous* and gradual, th gh con cealed. A certain ph m rous nsect (Chloeo) during ts dev lopm nt, mo lts, as sh wn by Sir J Lubbock, abo tw ty times and each tim und rgoes certain amount of chang and in this case w see th act of m tam rph osis perf rmed in a primary and grad l m n

ture of Limbs On the ordinary view of the independent creation of each being we can only say that so it is —that it has pleased the Creator to construct all the animals and plants in each great class on a uniform plan but this is not a scientific explanation

The explanation is to a l... ...mple ...sive ...ing ... some way to the modified form but often affecting by correlation other parts of the organisation In changes of this nature there will be little or no tendency to alter the original pattern or to transpose the parts The bones of a limb might be shortened and flattened to any extent, becoming at the same time enveloped in thick membrane so as to serve as a fin or a webbed hand might have all its bones or certain bones lengthened to any extent, with the membrane connecting them increased so as to serve as a wing yet all these modifications would not tend to alter the framework of the bones or the relative connection of the parts If we suppose that an early progenitor—the archetype as it may be called —of all mammals birds and reptiles had its limbs constructed on the existing general pattern for whatever purpose they served we can at once perceive the plain signification of the homologous construction of the limbs throughout the class So with the mouths of insects we have only to suppose that their common progenitor had an upper lip mandibles and two pairs of maxillæ these parts being perhaps very simple in form and then natural selection will account for the infinite diversity in the structure and functions of the mouths of insects. Nevertheless it is conceivable that the general pattern of an organ might become so much obscured as to be finally lost by the reduction and ultimately by the complete abortion of certain parts, ...as ... ...ain suctorial crustaceans the general pattern seems thus to have become partially obscured

There is another and equally curious branch of our subject namely serial homologies or the comparison of the different parts or organs in the same individual and not of the same parts or organs in different members of the same class Most physiologists believe that the bones of the skull are homologous—that is, correspond in number and in relative connexion—with the elemental parts of a certain number of vertebra The anterior and posterior limbs in all the higher vertebrate classes are plainly homologous So it is with the wonderfully complex jaws and legs of crustaceans. It is familiar to almo... ...n a ...als, ...ate ...ey ... metamorphosed leaves arranged in a ...pire In monstrous plants, we often get direct evidence of the possibility of one organ being transformed into another and we can actually see during the early or embryonic stages of development in flowers, as well as in crustaceans and many other animals, that organs which when mature become extremely different are at first exactly alike

How inexplicable are the cases of serial homologies on the ordinary view of creation! Why should the brain be enclosed in a box composed of such numerous and such extraordinarily shaped pieces of bone apparently representing vertebræ As Owen has remarked the benefit derived from the yielding of the separat... ... ...u similar bones have been created to form the wing and the leg of a bat used as they are for such totally different purposes, namely flying and walking? Why should one crustacean which has an extremely complex mouth formed of many parts consequently always have fewer legs or conversely those with many legs have simpler mouths Why ...ould the sepals petal... stamens and pistil... in each flower though fitted for such distinct purposes, be all constructed on the same pattern?

On the theory of natural selection we can to a certain extent answer these questions. We need not here consider how the bodies of some animals first became divided into a series of segments or how they became divided into right and left sides with corresponding organs, for such questions are almost beyond investigation It is, however probable that some serial structures are the result of cells multiplying by division entailing the multiplication of the parts developed f... ... ...or ...ttl... pecialised forms therefore the unknown progenitor of the Verte

und wate We ha e n m re reason to be b m h rel ti n, than w h to believ th t th s mular bones th hand of man, wing of a b t, and fi f porpoise, are rel ted to similar conditio s f l f N n upposes that the tripe n the wh lp f l the spots th y g blackb rd, are f any use t thes m ls.

the lar to ts co diti ns of lif i just as pe fect and as be tif l as i the ad lt animal. In h w impo tant mann r thi l as acted, l as ece tly bee w ll sho n by S r J L bbock in hi m ks tl cl e m l rity f the l æ of som nsects b l gi g t y d ff nt rd rs, and n tl d ss m lar ty f th larvæ of th nsects within th sam rde according

same larv has d ri g o stag t search f r food, and d ring an the tag has to s arch f a place f ttachm t. Cases can e n be gi l the larvæ f allied pecies, gro ps f peci diff n g m re from ach th than d th adults In m t cases, h r the larvæ, th gh acti st ll bey m re less l sely th l w f comm n mbry nic esem blance. Cirripedes aff rd a good in tance f thi th llustri us Cu did n t per ce that a barnacl was cr tacean b t a glance at the lar show thi n an nmi tak abl mann So agai th tw mai di si ns f cirriped s, th pedun lated and sessil th gh diff ri g w d ly t rnal ppear ance h l æ n all th tag barely

poss bl t d fin cl arly wl t m ant by th ganisati be g high l w B t n probably all disp t th t th butt rfly is h gh than th cat rp llar In some ases, h th mat re animal must b consid red as lo th scale than th larva, as w th certai paras tic crustaceans. T f ce again to cirriped th lar æ n th first tag h three pai f locom ti gans, simpl singl ye, and probosci f rmed m th with

which tl ey feed largely f r they increase m ch in si e In the seco d stage, answeri g to tl e chrysalis st ge f butte flies, they l ave x pairs f bea tifully con tructed natatory legs, a n f magnificent compo nd eyes, and x t

th y again tain a

but th y have no antennæ, and th r tw eye are n w reconve ted i to a minut s gl simpl ye-spot. In th s last and comp l t rriped m y b cons dered as tl r

a th larvæ becom u

rod t h ng th ord nary tructure and to what I ha called complem i tal mal s d in th l tte th d el pm nt has ass redly been retrograde f th mal is a mere sack, which h es f r a sh t time a d i destitut of mo th tomach, and ry othe organ f portance, excepting those fo reprodu tion

W are so m ch accustomed to see a diff e e in stru ture b tween tl embryo and tl e *adult, that we ar tempted t look at thi d f* f rence as in some necessary manner conting t n growth B t th re s no r ason why f instance th wi g of a b t, the fin f a po poise, sh uld n t h been sk tched out w th all th r p rts in prope propo ti n, as soon a any part becam bl In som wh l gro p f animals and in ce tain m mb rs of th gro p this th case, d the emb y doe n t t any period d ff widely from tl ad lt thus Ow n has remarked n regard to cuttle-fish Th e i m tam rphos the cephalo podic charact manifested l ng b f re th parts f the mbry are compl ted Land sh ll and fre h w t ustace ns are born ha g th prope f ms, wh l t th n ari m mb rs f tl same t o gre t classes pass thro gh cons d abl d ft n great l anges during th d l pm nt. Sp d rs, again, barely und g any m tam rphosis. The lar æ f m t insects pass thr gh worm l k tag wh th th y re act and ad pted to di er

ner Many insects and especially certain crustaceans show us what wonderful changes of structure can be effected during development Such changes however reach their acme in the so-called alternate generations of

I

a submarine rock *should produce first by* budding and then by transverse division a host of huge floating jelly fishes and that these should produce egg from which are hatched swimming animalcules which attach *themselves to rocks and become developed* into branching coralline and so on in an end less cycle The belief in the essential identity of the process of alternate generation and of ordinary metamorphosis has been greatly *strengthened by Wagner s discovery of the* larva or maggot of a fly namely the Cecid omyia producing asexually other larvæ and these others which finally are developed into mature males and females propagating their *kind in the ordinary manner by eggs*

It may be worth notice that when Wagner s remarkable discovery was first announced I was asked how was it possible to account for the larvæ of this fly having acquired the power *of a exual reproduction A long as the case* remained unique no answer could be given But already Grimm has shown that another fly a Chironomu reproduces itself in nearly the same manner and he believes that this

this ca e to a certain extent unites that of the Cecidomyia with the parthenogenesis of the *Coccidæ —the term partheno enesis imply* ing that the mature females of the Coccidæ are capable of producing fertile eggs without the concourse of the males Certain animals belonging to several classes are now known to *have the power of or linary reproduction at an* unusually early age and we have only to ac

stage viz that of the pupa—and we can per haps account for the marvellous case of the Cecidomyia

It has already been stated that various parts in the same individual which are exactly alike during an early embryonic period become widely different and serve for widely different purpose in the adult state So again it has been shown that generally the embryos of the most distinct species belonging to the same class are closely similar but become when *fully developed widely dissimilar A better* proof of this latter fact cannot be given than the statement by von Baer that The embryos of mammalia of birds lizard and snakes, probably also of chelonia are in their earliest *states exceedingly like one another both as a* whole and in the mode of development of their parts so much so in fact that we can often distinguish the embryos only by their size In my possession are two little embryos in spirit, *whose names I have omitted to attach and at* present I am quite unable to say to what class they belong They may be lizards or small birds or very young mammalia, so complete is the similarity in the mode of formation of the *head and trunk in these animals The extrem* ities however are still absent in these em bryos But even if they had existed in the earliest stage of their development we should learn nothing for the feet of lizards and mam *mal the wings and feet of birds no less than* the hands and feet of man all arise from the same fundamental form The larvæ of most crustaceans at corre ponding stages of de

law of embryonic resemblance occasionally lasts till a rather late age thus birds of the same genus and of allied genera often re*semble each other in their immature plumage* as we see in the spotted feathers in the young of the thrush group In the cat tribe most of the species when adult are striped or spotted in lines and stripes or spots can be plainly distinguished in the whelp of the lion and the puma We occasionally though rarely see something of the same kind in plants *thus the first* leaves of the ulex or furze and the first leaves of the phyllodineous acacias are pinnate r divided like the ordinary leaves of the l gu minosæ

direct relation to their conditions of existence

hatched in a nest and in the spawn of a frog

As we ha co clusi e evidence that th breeds of th p geon are d scended from a single wild peci s, I compared the y ung w l h rs afte bei g h tched I

mo in ic
feet and l ngth f l g th w ld pare t pe-cies, in po t rs, fantails, ru ts, barbs, drag ns,

l

in oth r charact s, ...
ha e bee ranked as d tin t g n ra if f und in a tat of nat re B t wl n the n tling b rd of th se se al breeds re placed in a row though most f th m co ld j t be d tin gu hed, th proporti nal diff re ce in th bo specified points were incomparably less than in th full grown birds. Some charact stic poi ts f diff rence—f r nstance th t f

th adult tat

Th se facts are explained by th abo e tw principles. Fanci rs select th d gs, h rses, p geons, &c., f r breed ng, wh n n arly grown up th y are diff re t wh th th d sired q alities are acquired arl l t in lif if th full gro n animal possesses th m And the

d not g rally ppear t a ry ly period of lif and are nh ted t corre po di g not arly period B t th case f the sh t faced t mbl which wh n tw l h rs ld possessed t prope charact rs, p th t th t th uni rsal rul f h th char act risti diff re ce m t th h ppeared t an arli period than al, f t so, th diff re ce m t h bee inh rited, t t correspo di g, b t t an arli age.
N w l t pply th se tw pri ciples t peci tat of ture. Let us tak gro p of birds, descended from som anci t f rm and modified thro gl nat ral selecti n f dif f re t hab ts. Th n, from th man slight suc cessi ari ti ns ha in superv ed in the se al peci es t n t ly a and ha g bee nh rited t corresponding age, th

prog nito may h ve become thro gh a l g course f modificati ad pted in o e le-scendant t act as hands, i another as paddl s, in an ther as wi gs b t on th abo tw principles the f re limbs w ll not have been m ch modified the mbry s of th se se ral form altho gh n ach form the f re-limb w ll differ gre tly in the ad lt tat Whate e in flu ce lo g-cont ued use or di use m y h e had n modif ng th limbs or other part of any pecies, this w ll chi fly sol ly have af fected t when n arly m ture when t was compelled to use its full pow rs to gain ts own li g and th effects thu produced will ha l

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m y h ve perv ned at a ery early period of life th t ps may h been inherited at an arli r age than th t t which th y first oc urred In th r of these cases, th young or embry w ll closely resemble th mature par t f rm, w h e see with th short faced tumbl And th is th rule f d elopment n certain wl l gro ps, in certain s b-gro p alo as w th ttle-fish, land shells, fresh w ter cru taceans, p d rs, and som m mb rs of th gre t lass f nsects. W th respect t the final se f th y ung in ch group n t passing tl ro gh any m tamorphosis, we an see that this w ld f ll w from th f ll w g cont g cies am ly from th y u g h vi g t pro de t ry earl age f th ir wn wants, and fro th ir f ll wi the sam hab-t of lif w th th ir parents f in this case it w uld b nd pensabl f r th ex t nce th t th y sh ld be modified th same mann as th pare ts. Agam, w th respect t th singu lar fact th t many t estrial and fresh w t animals d n t u d go any m tam rph sis, whilst marin m mbers of th same gro p

in that of Aphis if we look to the admirable drawings of the development of this insect by Professor Huxley we see hardly any trace of the vermiform stage

Sometimes it is only the earlier developmental stages which fail Thus Fritz Müller has made the remarkable discovery that certain shrimp-like crustaceans (allied to Penæus) first appear under the simple nauplius-form and after passing through two or more zoea stages and then through the mysis stage finally acquire their mature structure now in the whole great malacostracan order to which these crustaceans belong no other m n ber is r the oeas s be i that if there had been no suppression of development, all these crustaceans would have appeared as nauplii

How then can we explain these several facts in embryology —namely the very general though not universal difference in structure between the embryo and the adult —the various parts in the same individual embryo which ultimately become very unlike and serve for diverse purpose being at an early period of growth alike —the common but not invariable resemblance between the embryos or larvæ of the most distinct species in the same class —the embryo often retaining whilst within the egg or womb structures which are of no service to it, either at that or at a later period of life on the other hand larva which have to provide for their own wants being perfectly adapted to the surrounding conditions —and lastly the fact of certain larvæ standing higher in the scale of organisation than the mature animal into which they are developed? I believe that all the e facts can be explained as follows

It is commonly assumed perhaps from monstrosities affecting the embryo at a very early period that slight variations or individual differences necessarily appear at an equally early period We have little evidence on this head but what we have certainly points the other way for it is notorious that breeders of cattle horses and various fancy animals, cannot positively tell until some time after birth what will be the merits or demerits of their young animals We see this plainly in our own children we cannot tell whether a child will be tall or short, or what its precise features will be The question is not at what period of life each variation may have been caused but at what period the effects are displayed The cause may have acted and I believe often has acted on one or both parents before the act of generation It deserves notice that it is of no importance to a very young animal as long as it remains in its mother s womb or in the egg or as long as it is nourished and protected by its parent whether most of its characters are acquired a little earlier or later in life It would not signify for instance to a bird which obtained its food by having a much-curved beak whether or not whilst young it possessed a beak of this shape as long as it was fed by its parents.

I have stated in the first chapter that at whatever age a variation first appears in the parent it tends to re appear at a corr pond ing age in the offspring Certain variations can only appear at corresponding ages for instance peculiarities in the caterpillar cocoon or imago states of the silk moth

o reappear at a corresponding age in the off pring and parent I am far from meaning that this is invariably the case and I could give several exceptional cases of variations (taking the word in the largest sense) which have supervened at an earlier age in the child than in the parent

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ing not early period explain as I believe all the above specified leading facts in embryology But first let us look to a few analogous cases in our domestic varieties Some authors who have written on dog maintain that the greyhound and bulldog though o different are really closely allied varietie descended from the same wild stock hence I was curious to see how far their puppies differed from each other I was told by breeders that they differed just as much as their parents, and this, judging by the eye seemed alm st t t

was tol l that the foals of cart and race horses—breeds which have been almost wholly formed by selection under domestication—differed as much as the full grown animals but having had careful measurements made of the dams and of three-days-old colts of race and heavy cart horses, I find that this is by no means the case

conditi n, if th y pass thro gh cl sely similar mbry nic tages, w m y feel ass red that th y all are desce ded from e parent-f rm, and are th ref re cl sely related Th s, com munit mbry nic tru t ere eal commu nity of desce t b t diss m larity n mbry nic d lopm t doe n t pro d scommunity f desce t, fo in e f tw gro ps th d el p- m tal stages m y ha been pp ssed o m y h bee so greatly modified thro gh ad ptati to ew hab ts f life, as to be lo recognisable. E in gro ps, n which

I instance in ci pea s,

so lik sh ll fish, are t ce kn wn by th larvæ to bel g to the great class f crustaceans. As th mbryo ft n show u m re less plainly th tru ture f th less modified and anci t prog nit f th gro p, we can see why ancie t and e tin t forms so oft n resemble th ir ad lt tat the mbry of xisti g speci f the sam lass Agassi believes this to b uni rsal law f nat re and

oblite ted th by ocess variati ns ha ing pe ed t ry arly period f gro th, by ch an t h g been nh rited t an arli ag than that at which they first ppeared It h ld also b born n mind th t th l w m y b tr b t y t, ow ng to th geological record n t t ndin far gh back in tim may remain f lo g period f capabl f d m nstrati n. The law w ll t tr ctly h ld good in those ase in wh ch an anci t f m becam ad pted in ts larvæ tat to som pecial h of lif and t ansm tted th sam larval tat to wh l gro p f d sce d ts f ch lar æ ll n t sembl any till m re an t f rm ts ad lt tat

Th s, as t seem t me, th l ad g facts in mbry l gy wh ch are seco d to n m portance ar xplained th pri cipl f ari tions th many desce dants from som anci t prog nit h g ppeared t t ry arly period f l f and h b n i rited t correspo d g period. Embryl gy rise gre tly t re t wh w look t th mbry as pi t re, m re l ss bsc red, f th prog nito th ts adult r larval t te f all th m mbers of the sam gre t lass,

Rudimentary Atrophied and Aborted Organs

Organs or parts in this strange co d ti n b ring the plain tamp f inutility are ex trem ly comm n, or ev n gene al, througl out nature It w uld be mpossibl to name ne of the high r animals n which some pa t or tl er i t n a rudim ntary co ditio In tl e m m

used f r flight. Wh t can be m re s tl an th presence of teeth in fœtal wh al s, which wh n grown p ha n t a tooth n th rl ad o th teeth which ne r ut thro gh the g ms, in th ppe j ws f unborn cal s

R dim ntary rgans plainly declare the r gi and mean g n ari us wa s. Th re are beetl s bel gi g to cl sely all ed pecies, o e t th sam id ntical pec s, wh ch l e either full sized and pe fect w s, or mere rudiments f m mbran which n t rarely l unde wing-co rs firmly soldered t gett er and in th se cases t is mposs bl to do bt th t th rudim nts rep sent w gs. Rud m tary g ns som t m retain th i poten tiality thi occasi nall occ w th tl mam mæ f mal mammals, whi h h bee kn wn to become w ll de l ped and t secret milk So again in th dd rs in th g us Bos, there are n rmally f ur de el ped and two rudi m tary te ts b t th l tt n u d m tic cow som t mes become w ll de l ped and y ld milk. In regard to plants th petals are som tim rud m tary and som tim w ll d l ped in th ndi d als f the sam pe ci s. I ce tain plants ha ng separated se es K lre te f und th t by cross ng a peci s, n which th mal fl w in l ded a dim nt f a p til w th an h m phrodit peci s, hav g f co se a well-d l ped p til, th rud ment n th hybrid off pri g was m ch increased in siz and thi l arly h w that th rud m n tary and perfect pistil are essentially alike in nature. An animal m y possess vari us part in perfect tat and y t th y may n se be rudim tary f th y are useless thus th tadpole f th comm n sal mand w te wt, as Mr G H Lew remarks, has g lls, and passes ts xist ce n the w te b t th *Sal mand at a*, which li es h gh up am g th m tains, bri g f rth ts y un

through any larval stage for it is not probable that places well adapted for both the larval and mature stages under such new and greatly changed habits of life would commonly be found unoccupied or ill occupied by other organisms In this case the gradual acquirement at an earlier and earlier age of the adult structure would be favoured by natural selection and all traces of former metamorphoses would finally be lost

If on the other hand it profited the young of an animal to follow habits of life slightly different from those of the parent form and consequently to be constructed on a slightly different plan or if it profited a larva already different from its parent to change still further then on the principle of inheritance at corresponding age the young or the larva might be rendered by natural selection more and more different from their parents to any conceivable extent Differences in the larva might also become correlated with successive stages of its development so that the larva in the first stage might come to differ greatly from the larva in the second stage as is the case with many animals The adult might also become fitted for sites or habits in which organs of locomotion or of the senses &c would be useless and in this case the metamorphosis would be retrograde

From the remarks just made we can see how by changes of structure in the young in conformity with changed habits of life together with inheritance at corresponding ages animals might come to pass through stages of development perfectly distinct from the primordial condition of their adult progenitors Most of our best authorities are now convinced that the various larval and pupal stages of insects have thus been acquired through adaptation and not through inheritance from some ancient form The curious case of Sitaris—a beetle which passes through certain unusual stages of development—will illustrate how this might occur The first larval form is described by M Fabre as an active minute insect furnished with six legs two long antennæ and four eyes. These larvæ are hatched in the nests of bees and when the male bees emerge from their burrows in the spring which they do before the females the larvæ spring on them and afterwards crawl on to the females whilst paired with the males As soon as the female bee deposits her eggs on the surface of the honey stored in the cells the larvæ of the Sitaris leap on the eggs and devour them Afterwards they undergo a complete change their eyes disappear their legs and antennæ become rudimentary and they feed on honey so that they now more closely resemble the ordinary larvæ of insects ultimately they undergo a further transformation and finally emerge as the perfect beetle Now if an insect, undergoing transformations like those of the Sitaris were to become the progenitor of a whole new class of insects the course of development of the new class would be widely different from that of our existing insects and the first larval stage certainly would not represent the former condition of any adult and ancient form

On the other hand it is highly probable that with many animals the embryonic or larval stages show us more or less completely the condition of the progenitor of the whole group in its adult state In the great class of the Crustacea, forms wonderfully distinct from each other namely suctorial parasites cirripedes entomostraca and even the malacostraca, appear at first as larvæ under the nauplius-form and as these larvæ live and feed in the open sea, and are not adapted for any peculiar habits of life and from other reasons assigned by Fritz Müller it is probable that at some very remote period an independent adult animal resembling the nauplius existed and subsequently produced along several divergent lines of descent the above named great crustacean groups So again it is probable from what we know of the embryos of mammals, birds fishes and reptiles that these animals are the modified descendants of some ancient progenitor which was furnished in its adult state with branchiæ a swimbladder four fin like limbs and a long tail all fitted for an aquatic life

As all the organic beings extinct and recent, which have ever lived can be arranged within a few great classes and as all within each class have according to our theory been connected together by fine gradations the best, and if our collections were nearly perfect, the only possible arrangement would be genealogical descent being the hidden bond of connexion which naturalists have been seeking under the term of the Natural System On this view we can understand how it is that, in the eyes of most naturalists the structure of the embryo is even more important for classification than that of the adult. In two or more groups of animals however much they may differ from each other in structure and habits in their adult

rudimentary part is of greate size in the embryo relati ely to th adj ining parts, than in the adult so that the rgan at this early age is less rudimentary n cann t be said to be in any degree rudim ntary H nce rudi mentary organs in th adult are oft n said to ha retained thei mbryonic conditi n.

I ha now gi n th leading facts with re spect t rudime tary rgans. In reflecting n them, ery must be stru k with ast nish- me t f th sam reasoning pow which tells us that most parts and rgans are qui el adapted f certain purposes, t lls us with equal plainness that these rudim ntary r trophied rgans are imperfect and useless. In orks n natural history rudim ntary rgans are generally said to h been cre ted f the sake of symm try o m rd r t com plet the schem f nature B t this is not an xplanati n, merely a re tat ment of th fact. Nor is t consist nt with tself thus th boa-constrictor has rudim ts of hind limb and of pelvis, and if t be said that these bones ha e been retained to complete th sch m of nature, why as *Professo* W ismann asks, ha th y not been retained by oth snakes, which d not possess vestige f these sam bones. What w uld be thought f an astronomer who maintained that th satellites revol in ellipti courses round their plan ts for the sak of symm try because th plan- ts thus re ol round th sun An minent ph siologist accounts f th presence f rudi-mentary rgans, b supposing that th serv to excrete matt excess, matt injuri us to the *system* b t can w suppose that th min te papilla, which ft n represents th pistil in male flow rs, and which is f rmed of mere cellular tissue, an thus act Can w sup-pose that rudim tary teeth, which are subse-quently absorbed, are be ficial t th rapidly gro ing mbry nic calf b removing m tt so precious as phosphat f lim Wh n man s fingers ha bee amp tated, imperfect nails ha been known t ppear th tumps, and I could as soo believ that these estiges of nails are d loped in *order to* xcrete horn matte as that the rudim ntary nails the fin of th manatee ha been d loped f this same purpose.

On the iew of descent with modificati n, the origin of rudim tary rgans is compara-ti l simple and w can understand to a larg t t th laws go erning their impe fect d lopment. W ha plenty of cases of rudime tary organs in our d mestic produc-ti ns,—as the stump of a tail in tailless breeds, —th vesti e of an ear in earless breeds of sheep,—the reappearance of minute dangl ng horns in h rnless breeds of cattle m re es-pecially according to Y uatt, in y ung animals, —and the tate of the wh l fl wer in the caulifl w r W often see rudim nts f an parts in m nst rs b t I d bt wheth r an of these cases throw li ht n th origi f rud m ntary organs in a tate of nature f rthe than by showing that rudim nts can be pro-d ced f th balance f vid nce cl arly indicates that species under nature do n t und rgo great and abrupt chan es. B t we learn from th t dy of our domestic produc ti ns that th d suse of parts l ad to th ir red ced size and th t th result is inh rited

It ppears probabl that disuse has been th main agent in rend ring organs rudim ntary It wo ld t first lead by slow st ps to th m re nd m re compl t red ti n f a part, unt l

[illegible]

islands, which ha seld m been f rced b beasts f prey to tak fli ht, and ha e ulti m t ly lo t th power f flying Again, an gan, useful und certain conditi ns, might

[illegible]

ha aided in red cing th organ, until t was rend red harmless and rudim ntary

Any chan e in tru ture and functi n, which can be ffected by mall tages, is within th pow of nat ral selecti n so th t an organ rend red, thro gh changed hab ts of lif use less injuri us f o purpose, might be modified and used for anoth purpose An organ might, also, be retained f r ne alone of ts f rm fun ti ns. Organs, riginall f rmed b th aid f natural selecti n, wh n rend red useless may w ll be variable, f r their varia ti ns can n l nger be checked by natural selecti n. All this grees w ll with what w see und nature M reo at whate er period of lif eithe disuse selecti n reduces an organ, and this ill gen rall be when th being has com to maturity and has to rt ts full pow rs of acti n, th principle f inh ritance t corresponding ages will te d to reprod ce th rgan in ts red ced tate at th sam ma-

full formed This animal never lives in the water Yet if we open a gravid female we find tadpoles inside her with exquisitely feathered gills and when placed in water they swim about like the tadpoles of the water newt Obviously this aquatic organisation has no reference to the future life of the animal nor has it any adaptation to its embryonic condition it has solely reference to ancestral adaptations it repeats a phase in the development of its progenitors

An organ serving for two purposes may become rudimentary or utterly aborted for one even the more important purpose and remain perfectly efficient for the other Thus in plants the office of the pistil is to allow the pollen tubes to reach the ovules within the ovarium The pistil consists of a stigma supported on a style but in some Compositæ the male florets which of course cannot be fecundated have a rudimentary pistil for it is not crowned with a stigma but the style remains well developed and is clotl

[illegible]

[illegible] may become rudimentary for its proper purpose and be used for a distinct one in certain fishes the swimbladder seems to be rudimentary for its proper function of giving buoyancy but has become converted into a nascent breathing organ or lung Many similar instances could be given

Useful organs however little they may be developed unless we have reason to suppose that they were formerly more highly developed ought not to be considered as rudimentary They may be in a nascent condition and in progress towards further development Rudimentary organs on the other hand are either quite useless, such as teeth which never cut through the gums or almost useless such as the wings of an ostrich which serve merely as sails As organs in this condition would formerly when still less developed have been of even less use than at present they cannot [illegible] varia[illegible] lely by [illegible] They [illegible]ave been partially retained by the power of inheritance and relate to a former state of things It is however often difficult to distinguish between rudimentary and nascent organs for we can judge only by analog[illegible] t[illegible] na[illegible] [illegible]ays be

somewhat rare for beings thus provided will commonly have been supplanted by their successors with the same organ in a more perfect state and consequently will have become long ago extinct The wing of the penguin is of high service acting as a fin it may therefore represent the nascent state of the wing not that I believe this to be the case it is more probably a reduced organ modified for a new function the wi[illegible] other hand is [illegible]entary [illegible] limbs of the [illegible] organs which attain full functional development in higher vertebrates but according to the view lately advocated by Dr Günther they are probably remnants consisting of the persistent axis of a fin with the lateral rays of branches aborted The mammary glands of the Ornithorhynchus may be considered in comparison with the udders of a cow as in a nascent condition The ovigerous frena of certain cirripedes which have ceased to give attachment to the ova and are feebly developed are nascent branchiæ

Rudimentary organs in the individuals of the same species are very liable to vary in the degree of their development and in other respects In closely allied species also the extent to which the same organ has been reduced occasionally differs much This latter fact is well exemplified in the state of the wings of female moths belonging to the same family Rudimentary organ may be utterly aborted and this implies that in certain animals or plants, parts are entirely absent which analogy would lead us to expect to find in them and which are occasionally found in monstrous individuals Thus in most of th[illegible]

[illegible] this rudiment occasionally becomes perfectly developed as may sometimes be seen in the common snap-dragon In tracing the homologies of any part in different members of the same class nothing is more common or in order fully to understand the relations of the parts more useful than the discovery of rudiments This is well [illegible] in the drawings given by Owen of the leg bones of the horse ox and rhinoceros

It is an important fact that rudimentary organs such as teeth in the upper jaws of whales and ruminants can often be detected in the embryo but afterwards wholly disappear It is also I believe a universal rule that

understand the leading facts in Embry l gy namely th close resemblance in th indi d al mbryo of the parts which are h m l g s, and which when matured become widely dif ferent in structure and functi n and the resemblance of th h m l us parts rgans in allied tho gh distin t speci s, th ugh fitted in th adult tate f hab ts as diff rent as is possible. Larvæ are acti mbryos, which ha been specially modified in a greater r less degree in relati n to their hab ts f life, th their modifications inherited t co responding early age. On these sam principles, —and bearing in mind that when rgans are reduced in size, th from disuse thro h natural selecti n, t will generall be at that period of lif when the being has to provid f r ts wn wants, and bearing in mind how stro g is th f rce of inheritance—the occur re ce of rudim tary organs might e en h been anticipated Th mportance of mbry l gical charact rs and of rud mentary o gans in classificati n is int ll gibl n the v w th t a natural arrangem nt mu t be gen alogical.

Finally th se eral classes f facts which ha been consid red in this chapte seem to m to proclaim so plainl that th in ume able species, ne and famil s, w th which this wo ld is peopled, are all descended each within ts wn class gro p, from common parents, and ha e all been modified in the course of descent, th t I sho ld witho t hesi tati n ad pt this w e n if it were uns ported by oth r facts or argum nts.

size in the adult If for instance the digit of an adult animal was used less and less during many generations owing to some change of habits or *if an organ or gland was less and* less functionally exercised we may infer that it would become reduced in size in the adult descendants of this animal but would retain *nearly its original standard of development in* the embryo

There remains however this difficulty After an organ has ceased being u ed and has

disuse can go on producing any further effect after the organ has once been ren lere l func tionless Some additional explanation is here requisite which I cannot give If for instance it could be proved that every part of the or ganisation tends to vary in a greater degree *towar ls diminution than towards augmenta* tion of size then we should be able to under stand how an organ which has become useless would be rendered independently of the effects of disuse rudimentary and would at last be wl olly suppressed for the variations towards diminished size would no longer be checked by natural selection The principle of the economy of growth explained in a former chapter by which the materials forming any part if not useful to the possessor are saved as far as pos sible will perhaps come into play in rendering a useless part rudimentary But this principle *will almost necessarily be confined to the ear* lier stages of the process of reduction for we cannot suppose that a minute papilla for in stance representing in a male flower the pi til *of the female flower an l formed merely of* cellular tissue could be further re luced or ab sorbed for the sake of economi ing nutriment

Finally as rudimentary organs by v hat ever steps tl ey *may have been degrade l into* their present useless condition are the record of a former state of things and have been re tained solely through the power of inher itance —*we can understand on the genealogical* view of classification how it is that system atists in placing organisms in their proper places in the natural system have often found rudimentary *parts as useful as or even some* times more useful than parts of high physio-l al importance Rudimentary organs may

for its derivation On the view of descent with modification we may conclu le that the exis tence of organs in a rudimentary imperf ct, *and useless condition* or quite aborted, far from presenting a strange difficulty as they as uredly do on the old doctrine of creation might even have been anticipated in accord ance with the views here explained

Summary

In this chapter I have attempted to show

all living and extinct organisms are united by complex radiating and circuitous lines of af finities into a few grand classes,—tl e rules *follo ved and the difficulties encountered by* naturalists in their classifications —the value set upon characters if constant and prevalent whether of high or of the most trifling im portance or as with *rudimentary organs* of no importance —the wide opposition in value between analogical or adaptive characters and characters of true affinity and other such rules —all naturally *follow if we admit the* common parentage of allied forms together with their modification through variation and natural selection with the contingencies of l h ergence of character In con

varieties *of the same species*, however m u they may differ from eacl other in structure If we extend the use of this element of de nt —the one certainly known cause of sim

by the terms varieties pecies genera, fam ilies order and classes

On this same view of lescent with modifica tion most of the great facts in *Morphology* l ll e l le —wl etl er we look to the

and lateral homologies in eacl indivi animal and plant

On the principle of ucces i e slight varia tions, not necessarily or g nerally *supervening* at a very early period of life an l l eing in herited at a corre pon ling period we can

them increased size and vigour Th is ch fly wing t the *forms* which are crossed h ing bee exposed t som wh t diff rent cond tions of lif f r I h ascert ined by a l borious series of xperim ts that f all th ind d als of the same ariety be bjected d ring se ral generations to th sam cond tions, tl good d ed from cross in is oft n much d m nished wholly disappears. This n sid of the case On th otl id w kn w that species which ha lo g been posed t nearly uniform cond tions, whe th are subjected und confin m nt t n w and greatl ch ged cond t ns, th perish if th y

diffusion f tl sam speci s f r during ry lo g pe iods tl ere will alw ha e been a good hance f r wide migration by many m ans. A brok n o nt rrupted range m y ft n be accounted f by th e tinction f th spec s in th int rmed te regi ns. It cannot be d nied that w are as t very gnorant as to th f ll t nt of th various limatal and geograph l hanges wh ch l a e affected tl e

pot nt has been th influ nce f the Glacial period on th distrib tion f th sam and f all ed pec throu h t the w ld W are t nn fou dl ignorant f the man occa

probabl that this res lt is d to th ir ha g bee in fact subjected t great change in th ir cond tions of lif from bein compo nd ed of tw distinct organisat s. H wh ll explain in definit mann wh f instance an lephant f w ll n t breed und confinem t in ts natu co t wh l t th domestic p g dog will breed freel und th most d ersified cond t ons, will t th sam tim be abl to gi d finit answ t th q estio why two distinct pecies, wh n crossed as ll as th ir h brid ffspring are generall rend red m re or less t ril whil t t d mesticated n t es wh crossed and their mo grel ff pring re perfectl f rtil

Turnin to geographical distrib tion, th difficulties ncountered n th theory of desce t w th mod ficatio are serio en gh All th nd viduals f tl sam pecies, and all th species f th sam genus, o h gher gro p, are descended from common parents and th ref re in h distant and isolated parts of the w ld th ma now be f und the must in th co rse f ccessi g tions ha tra lled from som o point t all th oth rs. W are ften wl ll unabl t conject re h w tl is co ld h bee ffected Y t, as w ha reaso to belie that som pecies ha retained the sam specifi form f ry lo g periods of t m imm nsel lo g as m asured b ears, too much tress ought t t be laid th occasional wide

c es f th sam g nus is in som d gree lesse ed

As according t th theory of natural selectio an intermin ble number of int rmediate f rms must ha isted linking t geth r all th pecies in ach group by gradations as fine as are our existing arieties, t ma be asked Wh d w n t see these linkin form all around us Wh are n t all o ganic beings bl nded t g th n an inextricable chaos W th respect t xisting f rms, w sh uld rem mbe that w ha no right to expect (cepting in rare cases) to disco er *d ectly* connecting link between th m, but nly between ach and som tin t and s pplanted f rm L a w d area, which has duri g

occup ed by a closel allied pecies, w h no j t rigl t to xpect oft n t find int rmed t ar t es in th int rmediat zo s. F we ha reason to bel th t only a f w pecies f g nus und rgo change the th species becomin utt ly xtinct and l ing no mod fied proge Of th pecies which do chang nly f w w thin th sam country chang t th same tim and all mod ifications are slowly ffected I ha e also

CHAPTER XV

RECAPITULATION AND CONCLUSION

As THIS whole volume is one long argument, it may be convenient to the reader to have the leading facts and inferences briefly recapitulated

That many and serious objections may be advanced against the theory of descent with modification through variation and natural selection I do not deny I have endeavoured to give to them their full force Nothing at first can appear more difficult to believe than that the more complex organs and instincts have been perfected not by means superior to though analogous with human reason but by the accumulation of innumerable slight variations each good for the individual possessor Nevertheless this difficulty though appearing to our imagination insuperably great, cannot be considered real if we admit the following propositions namely that all parts of the organisation and instincts offer at least individual differences—that there is a struggle for existence leading to the preservation of profitable deviations of struct ... I

... good

... the truth of these propositions cannot I think be disputed

It is no doubt extremely difficult even to conjecture by what gradations many structures have been perfected more especially amongst broken and failing groups of organic beings which have suffered much extinction but we see so many strange gradations in nature that we ought to be extremely cautious in saying that any organ or instinct or any whole structure could not have arrived at its present state by many graduated step There are it must be admitted cases of pecial difficulty opposed to the theory of natural selection and one of the most curious of these is the existence in the same community of two or three defined castes of workers or sterile female ants but I have attempted to show how these difficulties can be mastered

With respect to the almost universal sterility of species when first crossed which forms so remarkable a contrast with the almost universal fertility of varieties when crossed I must refer the reader to the recapitulation of the facts given at the end of the ninth chapter which seem to me conclusively to show that this sterility is no more a ... idowment ... t kinds of ... it is inci... reproduc... systems of the intercrossed species. We see the truth of this conclusion in the vast difference in the results of crossing the same two species reciprocally —that is when one species is first used as the father and then as the mother Analogy from the consideration of dimorphic and trimorphic plants clearly leads to the same conclusion for when the forms are illegitimately united they yield few or no seed and their offspring are more or less sterile and these forms belong to the same undoubted species and differ from each other in no respect except in their reproductive organs and functions

Although the fertility of varieties when intercrossed and of their mongrel offspring has been asserted by so many authors to be universal this cannot be considered as quite correct after the facts given on the high authority of Gartner and Kolreuter Most of the varieties which have been experimented on have been produced under domestication and as domestication (I do not mean mere confinement) almost certainly tends to eliminate that sterility which judging from analogy would have affected the parent species if intercrossed we ought not to expect that domestication would likewise induce sterility in their modified descendants when crossed This elimination of sterility apparently follows from the same cause which allows our domestic animals to breed freely under diversified circumstances and this again apparently follows from their having been gradually accustomed to frequent changes in their conditions of life

A double and parallel series of facts seems to throw much light on the sterility of species, when first crossed and of their hybrid offspring On the one side there is good reason to believe that slight changes in the conditions of life give vigour and fertility to all organic beings We know also that a cross between the distinct individuals of the same variety and between distinct varieties, increases the number of their offspring and certainly gives to

has always been th case co sequently f rma tions much ld than any n w kn wn may l buried be eath th great oceans W th respe t t th lapse f time n t h g been s ffici nt since our plan t was co sol d ted f the assumed am unt of rganic chang nd this objection, as rged by Sir W ll am Th mpson, is probably f th gra t as y t ad nced I can nly say firstly th t w d n t kn w t

species h ll changed nd th y ha changed in th mann req ired by th theory f th y ha changed l wly and a grad ted mann W cl arly see this n th fossil remains from consec t f rmat in ari ably being m ch m re closely related to each th than are th foss ls from widely sepa ted f rm tions.

S ch is th m f th se ral chi f objections and difficulti which m y b justly rged gainst th theory and I h n w bri fly recap t lated th answ rs and xplana tions wl ich as far as I can see m y be gi n. I ha f lt these d fficult es far too h il d ring many years to d bt th w ght. B t t d serves pecial tice th t th m re important objections relat to q estions n hich w are confessedl gn rant n d w know h w gno ant w are W d n t know all th poss bl trans tional g ad tions betwee th simpl t and tl m t perfect gans t cannot be pret nded that w kn w ll th ried m ans f Distrib t n d ring th l g lapse f ars, that w kn w h w mperfect is th Geological Record. Se io is as th se se al object ns are, my j dgm t th y are by no m ans suffici t to rthrow th theory of desce t w th subseq t modification.

N w let us turn to th th d f the argum t Under d m ticat w see m ch ari ab l ty caused t l ast excited by changed cond tions f lif b t oft in so bscure mann that w are t mpted t consid th ariations as po taneous. Variab lity is g erned by many compl laws,—by correlated growth disuse f surro d culty in asce tain g n w

prod t ons ha e been mod fied but we may saf ly inf that tl e mo t h s been large and th t modifications can be nl r ted f r l g periods. As long as th cond t ons of life remain the same, w ha reason to b l e th t a mod ficat n, wh ch has already b en inh rited f many g rati ns, m y contin e to be h ted f r an alm t nfinit n mbe f g e ti ns. O the ther hand w h ve evidence th t arial l ty wl n t has o ce com nto play doe not cease under d mesti cati n f a ry lo g pe od n r d we know that t e r ceases, f r new ar et s are till occas nally prod ced by o olde t dome ti cated producti ns

Variab l ty is n t actually caused by man h only uni t t nally expose o gani be gs to n w co d tio of l f and then nature acts tl ganisat n and causes it to ary B t man an and does select the ri ti ns gi n to h m by nat re and th accum lates them n any desired mann r He thus adapts an mals and plants f r h wn be fit pleasure He m y do this m tl od cally he m y d it unconsci ly by p ese ing the ind d als m t usef l pleas g to him with t any t t n of lt ring th b eed It is certain that h can largely infl nce the characte f

ti t and useful d me t b eeds. Th t many breed prod ced by man h to a larg ex t t th charact f nat ral speci s, sh wn by th in tr cabl d ubts wheth many of th m are ari t aboriginally distinct pec s.

Th re is n reaso why th principles wh ch ha acted so ffici ntly und d mestication sh uld n t ha acted d nature In th ur al f f ured indi d als and aces d ring th constantly ecurrent Struggl f E istence w see powerf l and ev acting

case f many animals and plants during a ccession f peculiar seasons, and when naturalised

allied forms on either hand for the latter from existing in greater numbers would generally be modified and improved at a quicker rate than the intermediate varieties which existed in lesser numbers so that the intermediate varieties would in the long run be supplanted and exterminated

On this doctrine of the extermination of an infinitude of connecting links between the living and extinct inhabitants of the world and at each successive period between the extinct and still older ... ry ...s? ... ns ... nce of the gradation and mutation of the forms of life? Although geological research has undoubtedly revealed the former existence of many links bringing numerous forms of life much closer together it does not yield the infinitely many fine gradations between past and present species required on the theory and this is the most obvious of the many objections which may be urged against it Why again do whole groups of allied species appear though this appearance is often false to have come in suddenly on the successive geological stages? Although we now know that organic beings appeared on this globe at a period incalculably remote long before the lowest bed of the Cambrian system was deposited why do we not find beneath this system great piles of strata stored with the remains of the progenitors of the Cambrian fossils? For on the theory such strata must somewhere have been deposited at these ancient and utterly unknown epochs of the world's history

I can answer these questions and objections only on the supposition that the geological record is far more imperfect than most geologists believe The number of specimens in all our museums is absolutely as nothing compared with the countless generations of countless species which have certainly existed The parent form of any two or more species would not be in all its characters directly intermediate between its modified offspring any more than the rock pigeon is directly intermediate in crop and tail between its descendants, the pouter and fantail pigeons We should not be able to recognise a species as the parent of another and modified species if we were to examine the two ever so closely unless we possessed most of the intermediate links and owing to the imperfection of the geological record we have no just right to expect to find so many links If two or three or even more linking forms were discovered they would simply be ranked by many naturalists as so many new species more especially if found in different geological sub stages, let their differences be ever so slight Numerous existing doubtful forms could be named which are probably varieties but who will pretend that in future ages so many fossil links will be discovered that naturalists will be able to decide whether or not these doubtful forms ought to be called varieties? Only a small portion of the world has been geologically explored Only organic beings of certain classes can be preserved in a fossil condition at least in any great number Man ...

... pe ... c ... ave undergone modification though long as measured by years have probably been short in comparison with the periods during which they retain the same form It is the dominant and widely ra ...

... u scovery of intermediate links in any one formation less likely Local varieties will not spread into other and distant regions until they are considerably modified and improved and when they have spread and are discovered in a geological formation they appear as if suddenly created there and will be simply classed as new species Most formations have been intermittent in their accumulation and their duration has probably been shorter than the average duration of specific forms Successive formations are in most cases separated from each other by blank intervals of time of gre... ...

... lternate ... evel the ... anks During these latter periods there will probably be more variability in the forms of life during periods of subsidence more extinction

With respect to the absence of strata rich in fossils beneath the Cambrian formation I can recur only to the hypothesis given in the tenth chapter namely that though our continents and oceans have endured for an enormous period in nearly their present relative positions, we have no reason to assume that this

respects resembling vari ti s. Th se are tran relations on th view that ach pecies was independently created but are intell gibl if each existed first as ariet

As each species tends by ts geom trical rate of reproduction to increase inordinately in umber and as th modified descendants of ach species will be nabled to increase by as much as they becom more d ersified in habits and structure, so as t be abl to seize on man and widely differe t places in th econ om of nature, there will be a constant tendency in natural selectio to preserve th most di ergent ffspring f any species. Hence, durin lon contin ed co rse f modification, th slight diff rences charact ristic of arieties of th sam species, tend t be g mented into the gre t diff rences characteristic of th species of th sam g us. N w and impro ed vari ties will in tably pplant and t rminat the ld less mpro ed and intermediate ari ties and thus pecies are rend red t large t t defined and distin t objects. D minant peci belongin to th larger gro ps w thin ach class t nd to gi birth to n w and d minant f rms so that ach large group t nds to becom still larg and t the sam tim more di rg nt in charact B t as all gro ps annot thus go n increasing in size f th world w uld t l ld th m th more d minant gro ps be t th less d minant. Thus t nd ncy in th large gro p t go n increasing in size and d gu in charact to th w th th in tabl contingency f much tincti n, plains th arrang m nt f all th f rms of lif in gro ps subord nat to groups, all within f w gre t classes, which has pre ailed through t all tim This grand fact of the gro ping f all rgani beings und hat is called th N tural y t m, is tt ly inc plicabl n th theory f creation.

As natural selecti acts sol ly by accum lat g slight, successi f urabl ariations, t can prod ce great or udd n mod fications t can act nl by sh rt and slow t ps. H the cano of *Natur f t sal* t w which ers fresh add tio t ur kn wl edg t nds to confirm is thus theo int lligible W can see hy throughout t re th sam gen ral nd is gai ed by an almost infi nit di rsity of m ans, f ry peculiarit hen once acquired is lon inh rited and tru t res already modified in man diff re t w y ha to be adapted for the same general pur pose W can, in short, see why nature is prod gal in ariet tho gh niggard in inno ation. B t why thi sh uld be a law of nature if ach pec es l as been nd pendently created n man can explain.

Many th r facts are, as t seems to me ex plicable on this theory How strang it is that a bird und r th form of woodpeck r sh uld prey on insects on th ground that upland geese wl ch rarely or n er wim should possess w bbed feet that a thrush lik bird sh uld di e and feed n b-aq atic insects and th t a petrel sl ould ha th habits and stru ture fitting t f r th life f an wk and so in ndless th r cases. B t on th w f ach pec constantly trying to increase in number w th natural selection alwa s ready to ad pt th slowly arying descendants f ach to an unoccup ed r ll-occ p ed place in

n ture f this m y be larg ly attributed to th c f selecti n. Th t bea ty accord ing to ur sense of t, is not un ersal must be admitted b ry one who will look at

patt rns, and th nam nts to th males, and som t mes to both se es of many b rds, b tt fl es, and th animals. W th bird t has oft n rend red th ce of th mal mu cal t th f mal as well as to *ur ears*. Fl w rs and fru t ha been rend red con p cu us b brill ant col urs contrast w th th green f l a in rd that th fl w rs m y be readily seen, sited and f rtilised b insects, and th seed dissemin ted by birds. H w t com s that ce tain col rs, sounds, and form should gi pl as re t man and the l animals,— that is, h w th sense of bea ty in its simplest f rm was first acqu red —w d not kn w any m re than h w certain od urs and fla ours w re first rend red agreeabl

As t ral selecti n acts by competition, t adapts and mpro es th inhab tants f ch co try only in relati n to th co-inhab tants so that w need feel n urprise t th peci f any country alth h on th rd ary ew pposed t ha been cre ted and peciall adapted f r th t country bein be t and pplanted by tl nat ralised pro d t from an th land N ght we to marv l if all th co tri ance in t re b n t, as far as w an j dg absol t l perfect, as in

in new countries More individuals are born than can possibly survive A grain in the balance may determine which individuals shall live and which shall die —which variety or species shall increase in number and which shall decrease or finally become extinct As the individuals of the same species come in all respects into the closest competition with each other the struggle will generally be most severe between them it will be almost equally severe between the varieties of the same species and next in severity between the species of the same genus On the other hand the struggle will often be severe between beings remote in the scale of nature The slightest advantage in certain individuals at any age or during any season over those with which they come into competition or better adaptation in however slight a degree to the surrounding physical conditions will in the long run turn the balance

With animals having separated sexes there will be in most cases a struggle between the males for the possession of the females The most vigorous males or those which have most successfully struggled with their conditions of life will generally leave most progeny But success will often depend on the males having special weapons or means of defence or charms and a slight advantage will lead to victory

As geology plainly proclaims that each land has undergone great physical changes we might have expected to find that organic beings have varied under nature in the same way as they have varied under domestication And if there has been any variability under nature it would be an unaccountable fact if natural selection had not come into play It has often been asserted but the assertion is incapable of proof that the amount of variation under nature

... ort period a great result by adding up mere individual differences in his domestic productions and every one admits that species present individual differences But, besides such differences all naturalists admit that natural varieties exist which are considered sufficiently distinct to be worthy of record in systematic works. No one has drawn any clear distinction between individual differences and slight varieties or between more plainly marked varieties and sub species and species On separate continents, and on different parts of the same continent when divided by barriers of any kind and on outlying i lands what a multitude of forms exist, which some experienced naturalists rank as varieties others as geographical races or sub-species and others as distinct though closely allied species!

If then animals and plants do vary let it be ever so slightly or slowly why should not variations or individual differences, which are in any way beneficial be preserved and accumulated through natural selection or the survival of the fitt t? If ... t

... at ...

can be put to this power acting during long ages and rigidly scrutinising the whole constitution structure and habits of each creature —favouring the good and rejecting the bad I can see no limit to this power in slowly and beautifully adapting each form to the m t complex relations of life The theory of natural selection even if we look no farther than this, seems to be in the highest degree probable I have already recapitulated as fairly as I could the opposed difficulties and objections now l t us turn to the pecial facts and arguments in favour of the theory

On the view th at pecies are only stron ly marked and permanent varieties and that each species first existed as a variety we can see why it is that no line of d m ...

... acknowledged to have been produced by secondary laws On this same view we can understand how it is that in a region where many pecies of a genus ha e been produced and wh re th ...

L ... we might expect, as a gen ral rule to fin l it still in action and this is th case if varieties be incipient species Moreover the species of the larger genera, which afford the greater numl er of varieties or inc pi nt species retain to a certain degree the cl aracter of varieties for th y differ from each otl er l y a le s amount of d fference th an do the pecie of small ...

... round other pecies—in both

mad like our British species. On the vi w f instincts having been slowly acquired thro gh natural selecti n, w need n t marv l t som instincts being not perfect and liabl to mistakes, and at many in tincts ca si g oth r animals to suff

If species be nly well marked and permanent arieties, w can t nce see why th ir crossed ffspri sh uld f llow tl e sam com ple law in th ir d grees and kinds f resemblance to their pare ts,—in bein absorbed into each th r by cessi crosses, and n other such poi ts,—as do the rossed ff pring of acknowledged v ri t es. Th similarity would be tran fact, if species had been independently created and ari ti had been produced through secondary la s.

If w admit that th geol gical record is im perfect to an xtreme d gree th n th facts, hich th record doe gi trongl support the theory of desce t w th modificati n. N w species ha com on th ta lowly and t successi inter als and th am unt of chan alt equal intervals of tim w d l diff rent in different groups. Th extincti of species and of wh le gro ps of species which has played so con picuous part th histor f th o ganic world, almo t tabl f llow from the principl of natural selectio f ld f rm

their descendants, causes th f rms of life, after long interval of time, t ppear as f they had changed simultaneou l thro gho t th orld The fact of th f ssil remains f ach formatio being in som degree termediate in characte bet ee th f ssils n th f rmations abo and below is simply xplained by their int rmediate positio in th chain of escent. Th grand fact that all tinct being can be classed w th all rece t beings, naturally follow from tl li ing and th tinct being the offspring of comm pare ts. As pecies ha generally di rged in charact during their lo g course f desce t and modification, w can und tand wh t is that the more ancient forms, or earl pro nitors f ach group, so ofte occupy positio in some d gree intermediate between xisti g gro ps. Recent forms are generally looked pon as being, on the h le, high th scale of rganisation than ancient forms and th y must be high in so far as th later and more mpro ed f rms

co red th old r and less mpro ed

patil l w th num rous be ngs till reta nin simple and but l ttl improved stru tures, fitted f r simpl condit ns f l f t l ke compat bl w th som forms ha ing ret

d rl l law f th l ng ndu ance of all ed f rm o th sam co t nt,— f mars p al in Australia, of Ed tata in Am rica, and other ucl cases,—is t llıgıbl for with n th sam country th existing and tl ext nct w ll be closely allied by d sce t.

Looking to geo raphical distrib tion, if we adm t tl t th re ha been d ring th l ng course l g s m h m grat n from o part of th wo ld to anotl owing t f rm cl matal and geographical changes and to th many occasi nal and unkn wn means of dispersal, then w can und rstand, n the theory of descent w th modificat n, mo t of the great leading facts in Distrib tion. W an see wl y th re should be so striking a paralleli m in th distri t of organi beings thro gho t pace, and in th ir geological succession thro gh ut time f in both cases th being h been connected by th bond f ordinary gen tion, and th m an f mod fication ha been th sam W see th f ll mean ng of th wond ful fact, which has stru k ry tra ll nam ly that on th sam continent, und th most di rse cond t us, und h at and old

m untain and l wland, on deserts and marshes, most of th inhab tants w thin ach great class are plainl related f tl y are th descendants f th sam pro nit rs and arly col ni ts. O this sam principl of f rm r m grati n, combined n most case with modification, w can und rstand, b th d of th Glacial period, th id tit of som f w plants, and th close alliance f many thers, on tl most distant m untains, and n th northern and so thern t mperate zones and lik wise the cl se alliance of som of th nhab tants f th sea in th n rth rn and so th rn t mperate latitudes, th gh separated by th wh l intertropical oce n. Alth gh two co ntri s may present ph sical conditions as closely simi lar as th sam pec require w eed feel no urprise t thei inhab tants be g widely diff rent, if th y ha been f a l ng period completely und red from each oth f as

the case even of the human eye or if some of them be abhorrent to our ideas of fitness We need not marvel at the sting of the bee when used against an enemy causing the bee s own death at drones being produced in such great numbers for one single act and being then slaughtered by their sterile sisters at the astonishing waste of pollen by our fir trees at the instinctive hatred of the queen bee for her own fertile daughters at the Ichneumonidæ feeding within the living bodies of caterpillars or at other such cases The wonder indeed is on the theory of natural selection that more cases of the want of absolute *perfection* have not been detected

The complex and little known laws governing *the production of varieties are the same* as far as we can judge with the laws which have governed the production of distinct species *In both cases physical conditions* seem to have produced some direct and definite effect but how much we cannot say Thus when varieties enter any new station they occasionally assume some of the characters proper to the species of that station With both varieties and species use and disuse seem to have produced a considerable effect for it is impossible to re

as in the domestic duck or when we look at the burrowing tucu tucu which is occasionally blind and then at certain moles which are habitually blind and have their eyes covered with skin or when we look at the blind animals inhabiting the dark caves of America and Europe With varieties and species correlated variation seems to have played an important part so that when one part has been modified other parts have been necessarily modified With both parties and species reversions to long lost characters occasionally occur How inexplicable on the theory of creation is the

fact explained if we believe that these species are all descended from a striped progenitor in the same manner as the several domestic breeds of the pigeon are descended from the blue and barred rock pigeon!

On the ordinary view of each species having been independently created why should spe

they all agree? Why for instance should the colour of a flower be more likely to vary in any one species of a genus if the other species possess differently coloured flowers than if all possessed the same coloured flowers? If species are only well marked varieties, of which the characters have become in a high degree permanent, we can understand this fact for they have already varied since they branched off from a common progenitor in certain characters, *by which they have come to be specifically* distinct from each other therefore these same characters would be more likely again to vary *than the generic characters which have* been inherited without change for an immense period It is inexplicable on the theory of creation why a part developed *in a very unusual* manner in one species alone of a genus, and therefore as we may naturally infer of great importance to that species *should be eminently* liable to variation but on our view this part has undergone since the several species branched off from a common progenitor an unusual amount of variability and modification and therefore we might expect the part generally to be still variable But a part may be developed in the most unusual manner like the wing of a bat and yet not be more variable than any other structure if the part be com

Glancing at instincts marvellous as some are they offer no greater difficulty than do corporeal structures on the theory of the natural selection of successive slight, but profitable modifications We can thus understand why nature moves by graduated steps in en

tion tl ro s n the a lmiral le architectu al

having descended from a common parent, and having inherited much in common we can understand how it is that allied species, placed under widely different conditions yet follow nearly the same instincts why the thrushes of tropical and temperate America, for instance line their nests with

not be reduced or rendered rudim ntary t this early age. The calf, for in tance has inherited teeth, which ne cut through th gums of th per j w from an early progeni tor having well-d loped teeth and w may believe, that the teeth in th mature animal were formerl reduced b disuse owing to th tongue and palat o lips, havin becom excentl fitted throu h natural selecti n t browse without their aid wh reas th calf the teeth ha been left unaffected, and on th principe of inh ritance t correspondin es have been inherited from a remot period to the present da On th w of each organism with all ts separat parts having been pe call created, how tterl nexplicabl t that organs bearing th plain stamp of inutili t such as th teeth in th mbry nic calf or the sun lled wings und th sold red wing covers of man beetles, should so freq tl ccur N ture ma be said t hav taken ains to reveal be sch me of modification, by means of rudimentary organs, of mbry lo al and homologous tructures, b t w are too mad to understand h meaning

I have now recapitulated the facts and considerations which have thorou hl co vinced me that species ha bee modified, d ring a long course of descent This has been ffected hefl through th natural selection of numer ous successi sl ght f ourable variati ns aided in an important manner by th inh rited ffects of th use and disuse of parts and in an unimportant mann that is in relati n t adapti structures, wh th pa t present, b th direct actio of xt rnal cond tions, and b ariations which seem to us in our gnor ance to arise po taneousl It ppears that I form rl und rrated th freq ncy and al of these latt f rms of ariation, as leadin t permane t modifications of structure independentl of natural select n. B t as m conclusions ha latel bee much misrepresented and t ha bee tated that I ttrib t the modification of species f si l t nat ral selection, I ma be permitted to remark that in the first editio of this work and subseque tl I placed in most con p cuous position—namel t th lose of the Introduction —the follo ing word I am co vinced that natural selection has bee th mai b t not th xcl ve means of modification. This has been of no ail. Great is the pow of st ad misrepresentation but the history of sci nce show that fortunat ly this pow does not long end re

It can hardly be supposed that a *false theory* would explain, in so satisfactory a manner as does th theory of natural select n, the se ral large classes of facts abo e pecified. It has recentl been objected that thi is an un saf m thod f argum b t t m thod used n judging of th common nts of lif and has oft n been used b the gre test natural philosoph rs. The undulat ry theory of light has thus been arrived t and th beli f in th revol tion of th arth on its own axis was until lat l supported b hardly any direct evid nce It is n valid objecti n that sci ce as t throws no light o th far high prob l m of the essence origin of life Who can explain what is th esse ce of the ttracti n of gravity N on n w objects t f llowing out th results conseq t n this unknown lement of ttracti notwithstandin that Leibnitz forme l accused N wt n f introd cin occult qualities and miracles nto philosophy

I see no good reason why th ws gi en in this olum should shock th relig us feelings of an ne It satisfactory as sh wing how transi t such impressions are to remember that th greatest disco ry e mad by man, nam l the law of th ttracti n of gravity was also ttacked by Leibnitz, as ub ersive of natural, and inf rentiall of re ealed reli gi n. A celebrated utho and di in has writt n to me that "h has graduall learnt to see that t is ju t as nobl concept n of th Deit to beli that H cre ted f w riginal forms capable of self-d lopm t into oth and needful f rms, as to beli that He required fresh act f creatio t supply th oids caused by th act n of Hi laws."

Wh t ma be a ked until recently did nearl all th most min nt livin naturalists and geologists disbeli in th mutability of species It cannot be asserted th t rganic beings in stat of nature are subject to no ariation t cannot be proved that th am unt of ariation in th course of lo ages is lim ted quality no clear distinction has been, o can be drawn between species and well-m k ed vari ties. It cannot be maintained that pecies wh n intercrossed are invariabl terile and arieties n ariabl f rtile or th t ster ilit is pecial end wment and sign of cre tion. Th belief that species w re immutabl productions was almost una oidabl as lo g as th hist ry of th world was thought t be of short durati n and now that w have acquired som idea of th lapse of tim w are too pt

the relation of organism to organism is the most important of all relations and as the two countries will have received colonists at vari ous periods and in different n on n om e

t _ u en aitterent

On this view of migration with subsequent modification we see why oceanic islands are inhabited by only few species but of these why many are peculiar or endemic forms We clearly see why species belonging to those groups of animals which cannot cross wi le spaces of the ocean as frogs and terrestrial mammals do not inhabit oceanic islands and why on the other hand new and peculiar spe cies of bats animals which can traverse the ocean ar f nt from ence of ..nds and t e or all other terrestrial mammals are facts utterly inexplicable on the theory of independent acts of creation

The existence of closely allied or representa tive species in any two area implies on the theory of descent with modification that the same parent forms formerly inhabited both areas and we almost invariably find that wherever many closely allied species inhabit two areas some identical species are still com mon to both Wherever many closely allied yet distinct species occur doubtful forms and vari eties belonging to the same groups likewise occur It is a rule of high generality that the inhabitants of each area are related to the in habitants of the nearest source whence immi grants might have been derived We see this in the striking relation of n d n

and animals of the neighbouring American mainland and of those of the Cape de Verde Archipelago and of the other African islands to the African mainland It must be admitted that these facts receive no explana tion on the theory of creation

The fact as we have seen that all past and present organic beings can be arranged within a few great classes in groups subordinate to groups and with the extinct groups often fall ing in between the recent groups is intelligible on the theory of natural selection with its con tingencies of extinction and divergence of character On these same principles we see how it is that the mutual affinities of the forms within each class are so complex and cir cuitous We see why certain characters are far more serviceable than others for classification —why adaptive cha

t rom rudimentary parts, though of no service to the beings, are often of high classificatory value

_ u nheritance or community of de scent The Natural System is a genealogical arrangement with the acquired grades of dif ference marked by the terms, varieties, spe cies genera, families &c and we have to dis cover the lines of descent by the most perma ment characters whatever they may be and of however slight vital importance.

The similar framework of bones in the hand of a man wing of a bat fin of the porpoise and leg of the horse —the same number of verte bræ forming the neck of the giraffe and of the elephant —and innumerable other such facts, at once explain themselves on the theory of descent with slow and slight successive modifi cations The similarity of pattern in the wing and in the leg of a bat though used for such different purpose —in the jaws and legs of a crab —in the petal stamens and pistils of a flower is likewise to a large extent intelligible on the vi w of

c asses.

On the principle of successive variations not always supervening at an early age and being inherited at a corre ponding not early period of life we clearly s e why the embryos of mammals birds reptile and fishes should be so closely similar and so unlike the adult forms We may cease marvelling at the embryo of an air breathing mammal or bird having branchial slits and arteries running in loops like those of a fi l which has to breathe the air dissolved in water by the aid of well-developed branchiæ.

Disuse aided sometimes by natural selec tion w ll

caning of rudimentary organs. But disuse and selecti n will generally act on each creature when it has come to maturity and has to play its full part in the struggle for ex i tence and will thus have little power on an organ during earl life h nce the organ will

are suddenly gi en birth, through quit un explained means, to new and totally diff rent forms but, as I have attempted to sh w weighty evidence can be pposed to th admission of great and abrupt modificati ns. Under scientific point of view and as l ading to further investigation, b t little ad antage is gained b bel ving that new forms are sud denl de loped in an inexplicable manner from old and wid l diff rent forms, o er the old belief in the creation of species from the dust of the earth.

It may be asked how far I extend the doc trine of the modificatio of pecies. Th q estion is difficult to answ because th more distinct the forms are which we consider by so much th arguments in f our of community of descent becom f w in numbe and less in force. B t some arguments of the greatest eight e tend very far All the m mbers of whole classes are connected togethe b a chain of affinities, and all can be classed n the same principle in groups subordinat to groups. Fossil remains som times t nd to fill up very wid int rvals between xistin orders.

Organs in rudimentary condition plainl show that an earl progenit had th rgan in a ful d loped condition and this in som cases implies an normous amount of modification in the escendants. Throughout wh le classes arious structures are f rmed on th same pattern, and at ery earl a the m bryos closely resemble each othe Therefore I cannot doubt that th theory of descent with modification mbraces all th members of th same great class or kingd m. I beli that animals are descended from t most onl four or fi progenitors, and plants from an equal or lesse umbe

Analogy would lead m one step farther namel t the beli f that al animals and plants are descended from some on prototype. B t analogy may be dece tful guide. N ertheless al li ing things ha m ch in common, in their chemical composition, their cellular struct re th ir law of growth, and their liabi t to in urious infl nces. W see this en in so trifling fact as that th same poison often similarl affects plants and animals or that the poison secreted b the gall-fly produces monstrous growths on the wild rose or oak-tree. W th al organic beings ex cepting perhaps some of the v ry lowest, sex ual production seems t be essentiall similar W th all, as far as is at present known the germinal vesicl is the same so that all organ isms tart from common origin. If we look even to th two main divi ons—namely to the animal and egetable kingdoms—certain low f rms are so far intermediat in charact r that naturalists ha disp ted t which king dom th y should be ref rred. As Professor Asa Gra has remarked, "Th pores and oth r reproducti e bodies of many of th low algae may claim to ha e first characteristically animal, and then an unequi ocally vegetable existence" There re on th principle of n t ural selection with di ergence of characte it does not seem incredible that, from such low and intermediat form, both animals and plants may have been de loped and, if w admit this, we must lik wise admit that all th organic beings which have ve lived n this arth m be descended from som one primordial form. B t this inf rence is chiefl grounded n analogy and t is immaterial

clud that onl a ry few ha e left modified descendants. Fo as I ha e recently remarked in regard to th m mbers of ach great kingdom, such as the V rtebrata, Articulata, &c., w ha distinct idence in their mbryological homologous and rudimentary stru tures that within ach kingdom all th members are descended from a singl progenitor

When the ws ad anced by m in this volum and b Mr Wallace, when analogous vi ws on th origin of pecies are general l admitted, we can dimly foresee that th re will be a consid rabl re oluti n in natural history Syst matists will be abl to pursue their labours as at present but th y will n t be incessantl ha ted b th shad wy doubt wh ther this or that form be a tru species. This, I feel sure and I speak afte xperi nce will be n slight relief Th endless disputes w th or n t som fty pecies of British brambles are good species will cease. Systematists will have onl t decid (not that this will be eas) wh th any form be suffici ntly constant and distinct from other forms, to be capable of definitio and if definable wh the the differences be suffici ntl important to deser a specific name. This latter point will becom far more essential consideration than t is at present for dif rences, however light, between any two forms if not blended by inter mediate gradations, are looked at b most

to assume without proof that the geological record is so perfect that it would have afforded us plain evidence of the mutation of species if they had undergone mutation

But the chief cause of our natural unwilling ness to admit that one species has given birth to clear and distinct species is that we are al ways slow in admitting great changes of which we do not see the steps The difficulty is the same as that felt by so many geologists when Lyell first insisted that long lines of inland cliffs had been formed and great valleys ex cavated by the agencies which we see still at work The mind cannot possibly grasp the full meaning of the term of even a million years it cannot add up and perceive the full effects of many slight variations accumulated during an almost infinite number of generations

Although I am fully convinced of the truth of the views given in this volume under the form of an abstract I by no means expect to convince experienced naturalists whose minds are stocked with a multitude of facts all viewed during a long course of years from a point of view directly opposite to mine It is so easy to hide our ignorance under such expres sions as the plan of creation unity of de sign &c and to think that we give an ex planation when we only re state a fact Any one whose disposition leads him to attach more weight to unexplained difficulties than to the explanation of a certain number of facts will certainly reject the theory A few natural ists endowed with much flexibility of mind and who have already begun to doubt the im mutability of species may be influenced by this volume but I look with confidence to the future —to young and rising naturalists who will be able to view both sides of the question with impartiality Whoever is led to believe that species are mutable will do good service by conscientiously expressing his conviction for thus only can the load of prejudice by which this subject is overwhelmed be re moved

Several eminent naturalists have of late published their belief that a multitude of re puted species in each genus are not real spe cies but that other pecies are real that is have been independently created This seems to me a strange conclusion to arrive at They

quently have all the external characteristic features of true species,—they admit that these have been produced by variation but they refuse to extend the same view to other and slightly different forms Nevertheless they do not pretend that they can define or even conjecture which are the created forms of life, and which are those produced by secondary laws They admit variation as a *vera causa* in one case they arbitrarily reject it in another without assigning any distinction in the two cases The day will come when this will be given as a curious illustration of the blindness of preconceived opinion These authors seem no more startled at a miraculous act of cre ation than at an ordinary birth But do they really believe that at innumerable periods in the earth s history certain elemental atoms have been commanded suddenly to flash into living tissues? Do they believe that at each supposed act of creation one individual or many were produced? Were all the infinitely numerous kinds of animals and plants created as eggs or seed or as full grown? and in the case of mammals were they created bearing the false marks of nourishment from the moth er s womb? Undoubtedly some of the e same

has been maintained by several authors that it is as easy to believe in the creation of a mil lion beings as of one but Maupertuis philo sophical axiom of least action leads the mind more willingly to admit the smaller number and certainly we ought not to believe that in numerable beings within each great class have been created with plain but deceptive marks of descent from a single parent.

each pecies and I have been much censured for having thus expressed myself But un doubtedly this was the general belief when the first edition of the present work appeared I formerly spoke to very many naturalists on the subject of evolution and never once met

are however some who still think that pecies

and ot by miracul us acts f re ti n and as th most important f all ca ses of ganic change is n which is almost ind pe d nt f altered and pe haps s ddenly altered ph cal conditi ns, nam ly the m t al rel t n f r ganism to ganism,—th impro m t f e organism tailing th impro m nt r th ex terminati n f th rs t f llows, that the amount f rgani change in th f ssils f con secuti f rm ti ns probabl serv s as a fair measure f th relati th gh n t actual l pse f time. A umbe of species, h w keeping in body might remain f r lo period unchanged, whilst within th sam period se eral of these pecies by migrating int n w countries and coming into competiti n w th fore gn associates, might becom modified so that must t rrate th accurac f ganic chang as measure f tim

I th f ture I see pen fi lds f far m re important researches. P ch l gy w ll be se curely based th f und ti n already well laid by Mr H rbert Spe ce that f th eces sary acquirem t f each m ntal pow and capacity by grad ti n. M ch light will be thrown th rigin f man and his history

A th rs f th highest min nce seem to be fully satisfied w th th w th t ach species has bee ind pend tly created To m mind it accord bette with wh t w kn w f the laws impressed n matt by th Cre to that th product and xtincti n f th past and prese t inhab tants f th w ld sh uld ha bee d to secondary causes, lik those d t mining th birth and death f th indi dual. Wh I w all beings n t as pecial crea tions, b t as th lineal descendants f som few beings which li ed long bef re th first bed of th Cambrian tem as d posited, th y seem to m to becom nnobled J dging from th past, w may saf ly inf that t n li ing species will transmit ts naltered lik ess to distant f turit And f th peci now h g ry f w will transmit prog ny of any kind to far distant f turit f th mann in hich all rgani being are gro ped, sh w that th gre te umbe f species n ach g n us, and all th species in many g ra, ha e

— — —

t th larg r and d minant groups w thin ach h l w ll ltim t ly pre ail and procre

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we may feel certain that th rdinary success n by g n ati n has n nce been b k n, and that n cataclysm has desolated the wh le wo ld H nce w m y look with som confi dence to a secure future of gre t l ngth And as natural selecti n w ks sol ly by and f th good of each b ing all corporeal and m ntal dowm nts will t nd to progress toward pe fect n.

It is int resting to cont mplat a tangled bank, lothed w th many plants of man kinds, with birds singing on th bush s, with ari us insects flitting about, and with w rm rawl g thro gh the damp arth, and to reflect that these labo at l constructed f rms, so diff nt from ach th r and depe d t upo ach othe n so comple a manner ha all been prod ced by law acting around us. These laws, tak n in th largest sense being Growth with R prod cti n Inh ritance which is al m t implied by reprod ti n Variab lity *from th indirect and direct act n of th con dit ns of lif* and from use and disuse a Rati f Increase so high as to l ad to Struggle for Life, and as consequ ce to N t ral Selec ti n, ntailing D g nce f Characte and th Extincti n f less-impro ed f rms. Thus, from th war of nat re from famin and d th, th m t xalted object which w are capabl f co ce ing, nam ly th prod cti n f th high animals, directly f ll ws. Th re is grand ur in thi w f lif with ts se ral pow rs, ha ing been riginally bre thed by th Cre to into f w f rms into and th t, whilst thi plan t has g cycli n accord ing t th fixed law f gra ity from so simpl beginning ndl ss f rms m t beautiful and most w nd rf l ha e been, and are being e l ed.

naturalists as sufficient to raise both forms to the rank of species

Hereafter we shall be compelled to acknowledge that the only distinction between species and well marked varieties is that the latter are known or believed to be connected at the present day by intermediate gradations whereas species were formerly thus connected Hence without rejecting the consideration of the present existe [illegible] mediate grada [illegible] shall be led to [illegible] lue higher the [illegible] veen them It is quite possible that forms now generally acknowledged to be merely varieties may hereafter be thought worthy of specific names and in this case scientific and common language will come into accordance In short [illegible]

[illegible] nce This may not be a cheering prospect but we shall at least be free from the vain search for the undiscovered and undiscoverable essence of the term species

The other and more general departments of natural history will rise greatl[illegible]

[illegible] ve characters rudimentary and aborted organs &c will cease to be metaphorical and will have a plain signification When we no longer look at an organic being as a savage looks at a ship as something wholly beyond his comprehension when we regard every production of nature as one which has had a long history when we contemplate every complex structure and instinct as the summing up of many contrivances each useful to the possessor in the same way as any great mechanical invention is the summing up of the labour the experience the reason and even the blunders of numerous workmen when we thus view each organic being how far more interesting—I speak from experience—does the study of natural history become!

A grand and almost untrodden field of inquiry will be opened on the causes and laws of variation on correlation on the effects of use and disuse on the direct action of external conditions, and so forth The study of domestic productions will rise immensely in value A new variety raised by man will be a more important and interesting subject for study than one more species added to the infinitude of already recorded species. Our classifications will come to be as far as they can be so made genealogies and will then truly give what may be called the plan of creation The rules for classifying will no doubt become simpler when we have a definite object in view We possess no pedigrees or armorial bearings and we have to discover and trace the many diverging lines of descent in our natural genealogies by characters of any kind which have long been inherited Rudimentary organs will speak infallibly with respect to the nature of long lost structures Species and groups of species which are called aberrant, and which may fancifully be called living fossils, will aid us in forming a picture of the ancient forms of life Embryology will often reveal to us the structure in some degree obscured of the prototype of each great class

When we feel assured that all the individuals of the same species and all the closely allied species of most genera, have within a not very remote period descended from one parent and have migrated from some one birth place and when we better know the many means of migration then by the light which geology now throws and will continue to throw on former changes of climate and of the level of the land we shall surely be enabled to trace in an admirable manner the former migrations of the inhabitants of the whole world Even at present, by comparing the differences between the inhabitants of the sea on the opposite sides of a continent, and the nature of the various inhabitants on that continent, in relation to their apparent means of immigration some light can be thrown on ancient geography

The noble science of Geology loses [illegible] from the extreme imperfection of the record The crust of the earth with its imbedded remains must not be looked at as a well filled museum but as a poor collection made at hazard and at rare intervals. The accumulation of each great fossiliferous formation will be recognised as having depended on an unusual concurrence of favourable circ[illegible]

[illegible] we will [illegible]

[illegible] late as strictly contemporaneous two formations, which do not include many identical species by the general succession of the forms of life As species are produced and exterminated by slowly acting and still existing causes,

GLOSSARY

OF THE PRINCIPAL SCIENTIFIC TERMS USED IN THE PRESENT VOLUME

ABERRANT, Forms or groups of nimals or pla ts hich deviat in import t characters from their nearest allies, so as not t be easily ncluded th same group with them, are said t be berrant.

ABERRATION (in Optics), I the refractio of light by conve lens the ra passing through differe t parts of the lens are brought t focus t slightly d. erent distances,—this is called *pherical aer ration*, at the sam time the coloured ray are separated by the prismatic actio of the lens and likewise brought t focus t different distances,—this *chromatic aberration*.

AB ORMAL, Contrary t the g neral rule.

ABORTED, An organ is said t be borted, he ts developme t has bee arrested t ery early stage.

ALBINISM, Albinos are nimals hich the usual colouring matters characteristi of the species have not bee produced the skin and ts ppendages. Albinism is the stat of bei g albino.

ALGÆ, A class of plants ncluding the ordinary sea-weeds nd the filame t us fresh- ter eeds.

ALTER TI GENERATI NS, This term is p- plied to peculiar mode of reproductio which prevails among ma y of the low animals, in hich the gg produces h g form quit dif ferent from ts parent, but from hich the parent form is reproduced by process of budding, or by the di isio of th ubstance of the first product of the egg.

AMMO ITES, A group of fossil, spiral, chambered shells, alued t the existing pearly tilus, b t havi g the partitio bet ee the chambers ed in complicated patterns t their junctio th the outer al of the shell.

AN LOG That resemblance of structures hich depends po sim larity of f nction, as in the wings of nsects and birds. uch structures are said to be *analogous*, and t be *analogue* of each other

ANIMALCULE, A minut nimal generally pplied t those visible l by the microscope.

ANNELIDS, A class of worms in hich the surface of the body exhibits more or less distinct di isio int n gs or segments, generally pro ided th ppendages for locomotio and ith gills. It includes the ordinary marine worms, the earth-worms, and the leeches.

ANTENNÆ, Jointed organs ppended to the head in insects, Crustacea and ce ripedes, and not belongi g t the m th.

ANTHERS, Th ummits of th stamens of fl w rs, in which th polle fertilis g dust is prod ced.

APLA ENT LIA, APLA ENTATA or Aplace tal Mam mals, *Se* MAMMALIA.

ARCHETY L, Of or belo gi g t the Archetype or id al primiti e form pon hich all th being of group seem t be organised.

ARTICULA A, A gre t divisi of the imal ki dom characterised g nerally by ha g th urface of the body di ided to ri gs called *segm ts*, great or less umber of hich are furnished th jointed legs (such as insects, crustaceans nd ce ripedes)

ASYMMETRICAL, Having the tw sides unlike.

ATROPHIED, Arrested in dev lopme t t very early *stage*.

BALA US, Th ge us ncluding the commo acorn-shells which li abunda ce the rocks of th sea-coast.

B TRACHIA S, A class of animals allied t th reptiles, b t undergoing peculiar metamorphosis, which th young animal is generally aquatic and breathes by gills. (*Examples*, frogs, toads,

[illegible]

bodied animals, furnished ith b val e shell, t tached t submari bjects by stalk hich passes through an perture ne of th valves, and furnished w th fringed arms, by the actio of hich food is carried t the mouth.

BRA CHIÆ, Gills or organs for respiratio in w ter

BRANCHIAL, Pertaining t gills branchiæ.

CAMBRIA SYSTEM, A series of very ancie t Palæozoic rocks, bet ee the Laure tian and the Silurian. U til rece tly these were regarded as th oldest fossiliferous rocks.

CANIDÆ, The d g-family including th d g, wolf f x, jackal, &c.

CARAP CE, The shell veloping the anterior part of the body in crustaceans g nerally pplied also t the hard shelly p eces of th cirripedes.

CARBO IFEROUS, This term is pplied t the gre t formation hich includes, among ther rocks, th coal-measures. It belo gs t the oldest, or Palæozoic, yst m of form tions.

CAUD L, Of or belo ging t the tail.

CEPHALOPODS, The highest class of th Mollusca, soft-bodied animals, characterised by having the

I am indebted to the kindness of M W S. Dallas for th Glossary hich has bee give because several readers ha complained t me that some of the terms used ere unint lligible to them. Mr Dallas has ndeavoured t g ve the xplanations of the terms in as popular form as possible.

FLORA. The totality of the plants growing naturally in a country or during a given geological period.

FLORETS. Flowers imperfectly developed in some respects, and collected into a dense spike or head, as in the grasses, the dandelion, &c.

FŒTAL. Of or belonging to the fœtus, or embryo in course of development.

FORAMINIFERA. A class of animals of very low organisation, and generally of small size, having a jelly-like body, from the surface of which delicate filaments can be given off and retracted for the prehension of external objects, and having a calcareous or sandy shell, usually divided into chambers, and perforated with small apertures.

FOSSILIFEROUS. Containing fossils.

FOSSORIAL. Having a faculty of digging. The Fossorial Hymenoptera are a group of wasp-like insects, which burrow in sandy soil to make nests for their young.

FRENUM (pl. FRENA). A small band or fold of skin.

FUNGI (sing. FUNGUS). A class of cellular plants, of which mushrooms, toadstools, and moulds, are familiar examples.

FURCULA. The forked bone formed by the union of the collar-bones in many birds, such as the common fowl.

GALLINACEOUS BIRDS. An order of birds of which the common fowl, turkey, and pheasant, are well-known examples.

GALLUS. The genus of birds which includes the common fowl.

GANGLION. A swelling or knot from which nerves are given off as from a centre.

GANOID FISHES. Fishes covered with peculiar enamelled bony scales. Most of them are extinct.

GERMINAL VESICLE. A minute vesicle in the eggs of animals, from which development of the embryo proceeds.

GLACIAL PERIOD. A period of great cold and of enormous extension of ice upon the surface of the earth. It is believed that glacial periods have occurred repeatedly during the geological history of the earth, but the term is generally applied to the close of the Tertiary epoch, when nearly the whole of Europe was subjected to an arctic climate.

GLAND. An organ which secretes or separates some peculiar product from the blood or sap of animals or plants.

GLOTTIS. The opening of the windpipe into the œsophagus or gullet.

GNEISS. A rock approaching granite in composition, but more or less laminated, and really produced by the alteration of a sedimentary deposit after its consolidation.

GRALLATORES. The so-called wading-birds (storks, cranes, snipes, &c.), which are generally furnished with long legs, bare of feathers above the heel, and have no membranes between the toes.

GRANITE. A rock consisting essentially of crystals of felspar and mica in a mass of quartz.

HABITAT. The locality in which a plant or animal naturally lives.

HEMIPTERA. An order or sub-order of insects, characterised by the possession of a jointed beak or rostrum, and by having the fore-wings horny in the basal portion and membranous at the extremity, where they cross each other. This group includes the various species of bugs.

HERMAPHRODITE. Possessing the organs of both sexes.

HOMOLOGY. That relation between parts which results from their development from corresponding embryonic parts, either in different animals, as in the case of the arm of man, the fore-leg of a quadruped, and the wing of a bird; or in the same individual, as in the case of the fore and hind legs in quadrupeds, and the segments or rings and their appendages of which the body of a worm, a centipede, &c., is composed. The latter is called *serial homology*. The parts which stand in such a relation to each other are said to be *homologous*, and one such part or organ is called the *homologue* of the other. In different plants the parts of the flower are homologous, and in general these parts are regarded as homologous with leaves.

HOMOPTERA. An order or sub-order of insects having (like the Hemiptera) a jointed beak, but in which the fore-wings are either wholly membranous or wholly leathery. The Cicadæ, frog-hoppers, and Aphides, are well-known examples.

HYBRID. The offspring of the union of two distinct species.

HYMENOPTERA. An order of insects possessing biting jaws and usually four membranous wings in which there are a few veins. Bees and wasps are familiar examples of this group.

HYPERTROPHIED. Excessively developed.

ICHNEUMONIDÆ. A family of hymenopterous insects, the members of which lay their eggs in the bodies or eggs of other insects.

IMAGO. The perfect (generally winged) reproductive state of an insect.

INDIGENES. The aboriginal animal or vegetable inhabitants of a country or region.

INFLORESCENCE. The mode of arrangement of the flowers of plants.

INFUSORIA. A class of microscopic animalcules, so called from their having originally been observed in infusions of vegetable matters. They consist of a gelatinous material enclosed in a delicate membrane, the whole or part of which is furnished with short vibrating hairs (called cilia), by means of which the animalcules swim through the water or convey the minute particles of their food to the orifice of the mouth.

INSECTIVOROUS. Feeding on insects.

INVERTEBRATA, or INVERTEBRATE ANIMALS. Those animals which do not possess a backbone or spinal column.

mouth surrounded by a greater or l ss number of fleshy arms or tent cle h ch n most living pec es, are furr ished ith sucking-cups (*Ex ples* cuttle-f h n utilus)

CETACEA An order f Mammal a inclu l ng the e

CHELONIA A order of reptiles including the turtle tort ses, &c

CIRRIPEDES An order of crustaceans includi g the bar acl and acorn shells Their young resemble th se of ma y ther crustace ns in form but when mature they re lways attached to th r objects, e ther directly or by m ns of a st lk and their bodies are enclos d by a calcareous hell con posed of ever l pi ces two of which can pen to giv ssue to a bunch f curled j nt d tentacles, which r pre nt th l mbs

COCCUS, The genus of i sects includ ng the cochi l al In tl ese the male is a minut wi ged fly d the female gener lly a mot nless b rry like mass

COCOON A case usually of s lky m terial n wh ch in cts are f eque tly en l ped duri g the sec nd o rest ng tage (pupa) f th r exi te ice. The t rm coco n stage is h re u d as qu val t to pupa st ge

CŒLOSPERMOUS A term applied t tho fruits f th Umbell f rae hich h e th ed hollo ved on the i er f ce

COLEOPTERA beetles an order of insects hav g a biti g mouth nd the first pa r f w ngs m re or less horny forming sh ths f r the ec nd p r ar d usually m eting in a t ght lin d wn the middle of th b ck

COLUMN A pecul r rg n n the flow rs f orch ds in wl ch the tan ns, tyl nd stigm (or th reproduct e parts) a e u ited

COMPOSITE or COMPOSITOUS PLANTS, Plants in wh cl th nflorescence co s sts of num rous m ll flo e s (fl r t) bro gl t t g th r into a den h d the base of wh ch is en l ed by common l pe (*E mpl* tl e d y dai d l n &c)

CONFERVÆ, Th fil m ntou weed f fre h w t r

CONGLOMERATE A rock m d up f f g ents f rock o p bl l m nted tog th by som ther m ter al.

COROLLA The econd envelope of a fl wer usu lly comp sed f col red l f l ke rg ns (petals) h h may b united by the r edg e ther i the basal p rt r thro ghout

CORRELATION The n rm l co c dence of e phe me on cl r t &c w th anotl r

CORYM A bu ch f fl rs in h h tl pr g g from th l e p rt f th fl w r stalk r p p rted o l g talks s as to be ne rly n a le el ith th pper

COTYLEDONS, The fir t seed l av f pla ts

CRUSTACEA, A lass f ti ul ted n m l lavi g th k n of th body g r lly n r r l ss l rd ened by the d position of calcareous matt r breathi g by means of gills (*Ex mples* crab, lobster shr mp &c.)

CURCULIO The old gen ric term f r the beetl s kno n as w e ls characte ed by th ir f ur joi ited feet a d by tl e h ad bei g prod ced i to a sort of beak upon the s d s of hich the a tennæ re in rted

CUTANEOUS Of r belong ng to the kin.

DEGRADATION The wear ng down of l nd by the actio i of the ea or of meteoric age c es.

DENUDATION The wear ng ay f the surface of tl e land by at r

a d the ld wood (exog nous gro th) d ly the reticul t o i of the v is of tl e leav s. The parts of the fl ers are ge ierally n mult ples of five

DIFFERENTIATION The p r tion or discrimi ti n of p rts r rgans wl i h n n pler f rms of life a e m e or less u i ted

DIMORPHIC H ng two d t nct form —D m rphism s tl e co d ti of th ppe ce of the sam pec es u d t o d ssin lar f rms

DIŒCIOUS Havi g th orga f the s xes upon distinct idi du ls.

DIORITE, A p cul r f rm of gre t ne

DORSAL, Of or bel ng g to th b ck

EDENTATA A pecul ar order of quadrupeds, har act rised by the b ence f t least tl e m ddl in c so (fro it) teeth i i b th j s. (*E mples*, the

con t tut tl e true g i of fl ght.

EMBRYO Tl yo g n l und rg i g de el p m t v tl n the gg or b

EMBRYOLOGY Th study of the d v lopme t of the mbry

l

t a m ll pr p rt n f h lls id t cal th spec es n w l v g

EPHEMEROUS INSECTS I ects all ed t the M y fly

FAUNA Tl e t tal ty f tl m ls i turally in-

————— ..

FLORA. The totality of the plants growing naturally in a country or during a given geological period.

FLORETS. Flowers imperfectly developed in some respects, and collected into a dense spike or head, as in the grasses, the dandelion, &c.

FOETAL. Of or belonging to the foetus, or embryo course of development.

FORAMINIFERA. A class of animals of very low organisation, and generally of small size, having a jelly-like body, from the surface of which delicate filaments can be given off and retracted for the prehension of external objects, and having a calcareous or sandy shell, usually divided into chambers, and perforated with small apertures.

FOSSILIFEROUS. Containing fossils.

FOSSORIAL. Having a faculty of digging. The Fossorial Hymenoptera are a group of wasp-like insects, which burrow in sandy soil to make nests for their young.

FRENUM (pl. FRENA). A small band or fold of skin.

FUNGI (sing. FUNGUS). A class of cellular plants, of which mushrooms, toadstools, and moulds, are familiar examples.

FURCULA. The forked bone formed by the union of the collar-bones in many birds, such as the common fowl.

GALLINACEOUS BIRDS. An order of birds of which the common fowl, turkey, and pheasant, are well-known examples.

GALLUS. The genus of birds which includes the common fowl.

GANGLION. A swelling or knot from which nerves are given off as from a centre.

GANOID FISHES. Fishes covered with peculiar enamelled bony scales. Most of them are extinct.

GERMINAL VESICLE. A minute vesicle in the eggs of animals, from which development of the embryo proceeds.

GLACIAL PERIOD. A period of great cold and of enormous extension of ice upon the surface of the earth. It is believed that glacial periods have occurred repeatedly during the geological history of the earth, but the term is generally applied to the close of the Tertiary epoch, when nearly the whole of Europe was subjected to an arctic climate.

GLAND. An organ which secretes or separates some peculiar product from the blood or sap of animals or plants.

GLOTTIS. The opening of the windpipe into the oesophagus or gullet.

GNEISS. A rock approaching granite in composition, but more or less laminated, and really produced by the alteration of a sediment
ary deposit after its consolidation.

GRALLATORES. The so-called wading-birds (storks, cranes, snipes, &c.), which are generally furnished with long legs, bare of feathers above the heel, and have no membranes between the toes.

GRANITE. A rock consisting essentially of crystals of felspar and mica in a mass of quartz.

HABITAT. The locality in which a plant or animal naturally lives.

HEMIPTERA. An order or sub-order of insects, characterised by the possession of a jointed beak or rostrum, and by having the fore-wings horny in the basal portion and membranous at the extremity, where they cross each other. This group includes the various species of bugs.

HERMAPHRODITE. Possessing the organs of both sexes.

HOMOLOGY. That relation between parts which results from their development from corresponding embryonic parts, either in different animals, as in the case of the arm of man, the fore-leg of a quadruped, and the wing of a bird; or in the same individual, as in the case of the fore and hind legs in quadrupeds, and the segments or rings and their appendages of which the body of a worm, a centipede, &c., is composed. The latter is called *serial homology*. The parts which stand in such a relation to each other are said to be *homologous*, and one such part or organ is called the *homologue* of the other. In different plants the parts of the flower are homologous, and in general these parts are regarded as homologous with leaves.

HOMOPTERA. An order or sub-order of insects having (like the Hemiptera) a jointed beak, but in which the fore-wings are either wholly membranous or wholly leathery. The Cicadæ, frog-hoppers, and Aphides, are well-known examples.

HYBRID. The offspring of the union of two distinct species.

HYMENOPTERA. An order of insects possessing biting jaws and usually four membranous wings in which there are a few veins. Bees and wasps are familiar examples of this group.

HYPERTROPHIED. Excessively developed.

ICHNEUMONIDÆ. A family of hymenopterous insects, the members of which lay their eggs in the bodies or eggs of other insects.

IMAGO. The perfect (generally winged) reproductive state of an insect.

INDIGENES. The aboriginal animal or vegetable inhabitants of a country or region.

INFLORESCENCE. The mode of arrangement of the flowers of plants.

INFUSORIA. A class of microscopic animalcules, so called from their having originally been observed in infusions of vegetable matters. They consist of a gelatinous material enclosed in a delicate membrane, the whole or part of which is furnished with short vibrating hairs (called cilia), by means of which the animalcules swim through the water or convey the minute particles of their food to the orifice of the mouth.

INSECTIVOROUS. Feeding on insects.

INVERTEBRATA, or INVERTEBRATE ANIMALS. Those animals which do not possess a backbone or spinal column.

mouth urrou ded by a gr ater or l s numb r of fl hy rms r tent cles which in most hv g spec es re furi hed with sucking cup (*Ex mpl s* cuttle-f h r autilus)

CETACEA An ord r of Mamm l a including the wh les d lphins &c. having the form f the body fish like tl e skin naked and only the f re-l nbs developed

CHELONIA An rder f rept les includi g the tur-

th s of m ny othe crustacean in form but wl en mature they are al ays attach d to ther objects c ther d rectly or by mean of a st lk and the r bodies are encl ed by a c lcareous hell *c mposed of several piec s twa f 1 h ch can pen* to g ve issue to a bunch of curled jointed tenta cles wh ch repre ent th limb

Coccus The g nus of insects includ ng th cochi r al In the e them l is a n nut i ged fly a d the female generally a m tio les berry l ke m

COCOON A case usually of s lky mat rial in wh ch ects re *frequei tly envel ped d ring the seco d* or re ting stage (p pa) of th ir ist ce The term c coon stage is here used as equi alent to pupa stage

CŒLOSPERMOUS A term appl ed to those fru ts of the Umbell f ræ h ch h ve th seed hollowed on the in r f ce

COLEOPTERA b tle an rder f in ects ha i g b t g m uth nd th *first pa r f w gs m re r* less horny f rm g heaths for the econd p and u ually meeting in a stra ght l e down the m ddle of the back

COLUMN A peculi r g n in the flowers of orchids i i v l h the tamens tyle a d stigm (r the re-product e parts) ar united

COMPO IT E COMPOSITOUS PLANTS Plants in *h cl tl e i fl resc nce c i ists of numerous m ll* flo e s (fl ets) bro gl t t g tl er int a den e he d the base of wh ch is l ed by a commo en el pe (*F a gle* tl e d y l del &c)

CONFERVA, Th filam ntous w eds f f e h t r

CONGLOME ATE, A rock m de p of f gm ts f rock p bbl s c me ted t gether by s me ther n t al

COROLLA The eco d e v l pe f a flow r usu lly c npos d f l ur d le f l ke rg (p tals) h h m y b u ted by th r dg s e th r n the *basal p rt r tl rough ut*

C r Tl rmal co n d ce of phe-

CRU T CEANS, A lass f t cuiatcu m b tl e k n of the body ge rally n e r l ss h rd en d by the depo t on of calcareous m tt r

breatl ing by me ns *of g lls (Exampl s cr b*, lobster h imp &c)

CURCULIO The old gener c term f r the beetles kno n as v eev ls cl a acterised by their f ur jo nted feet and by tl e h d being produced to a sort of be k up n the s des of hich the antennæ re inserted

CUTANEOUS, Of or belong g to the skin.

DEGRADATION The v earing do n of l nd by the action f the ea r of meteor c gencies.

DENUDATION The we r g away f the surf ce of tl e l d by v t r

DEVONIAN SYSTEM r form t on A seri s of P læo-c rocks i clud g the Old Red S nd to

DICOTYLEDONS r DICOTYLEDONOUS PLANTS, A clas *of pl ts charact rized by havi g t seed l a es*, by the format n of n wood b t e n tl bark and tl e old w od (ex g nous gro th) d by the ret culation f the ins f the lea s. The p rts of th flow rs are gei er lly i i n ult ples of fi e

DIFFERENTIATION The par tion o d scrimi t n of p rt or organ wl ich su pl r f rms of lf *a e n re or less un ted*

DIŒCIOUS H i g the o g s of the xes upo dis-t ct n d d ls

DIORITE, A p uli r f rm f gre nst ne

DORSAL, Of r belong g t the back

EDENTATA A peculi ar rder f q adrupeds, har acter sed by th b ence f t l ast th m ddl n-c r (f o t) t th i botl ja s (*Example* the

EI

co t tute the t e rgai s f fl ght.

EMBRYO Th *young r al d gon g d l p-*ment tl tl e gg r wo b

EMBRYOLOGY Th tudy of the dev lopme t of th embryo

ENDEMIC Peculiar to a g en locality

E OMOST A di n f tl e class C ustacea.

are g rally f mall ze

EOCENE Th a lie t f the tl ee d v ors f the T rt y *poch f geol g ts Rock f tl is g* con ta n m ll pr p ti f h lls ide t cal th pec e r l i g

EPHEMEI OUS I SECTS, I sect ll ed t the M y fly

FAUN Tl e t t l ty f tl e n m ls turally in-h b

FE

FERAL, H v ng become wild from tate of culti t n or d mest cation

FLORA, Th t tality f th pla ts gro g tur- ally in country duri g g geol g cal pe od.

FLORETS, Fl ers mperfectly d l ped som respects, d collected t d nse p k h d as in the grasses, th da d l &c.

FŒTAL, Of bel nging t th fœtus, bry

f th ir y g

FRE UM (pl. FREN) A mall b d f ld f skin.

FU (sing FU US) A class of cellular pl ts, f hich mushrooms, toadstools, nd m ulds, are familiar ampl s.

F RCUL Th f ked bo f rmed by th f th collar-bo es m y b rds, uch as th com m f l.

GALLI EO B RDS, A rd of birds f which th comm f wl, turk y d ph as t, re ll-kn mples

G LLUS, Th g us f b rd h h clud th com m f l

GA LI A lli g k t from h ch r ses re g ll as from ce tre

GA FISHES, Fish co red th peculiar na lled b y scal Most f th m are t t.

GERMI VES LE, A mi t es cl th gg f nimals, from l ch d el pm t f th mbry proceeds

GLACI l ERI A p od f gre t cold d f m us t ns f ce po th urf ce of th arth It is bel ed th t gla l periods h oc- curred repe tedly dur g th geol g cal history f th th, b t th t rm is g ll ppl ed t th l se of th T tiary poch h ly th h l f Europe as bjected t rct lim t

GLA A g fich ecr t separates som pecul p od ct from th blood sap f m ls pla ts

GLOTTIS, Th pe g f th d p pe t th œs pl gu gull t

G EISS, A rock pp oach g gr t co po t n, b t m re less laminated, d really prod ced b th lter t f sedim tary d po t aft ts co usol dat

GRALLA ES, Th o-called d g birds (t ks, cra es pes, &c.) hich are g rally fur l ed th l ng legs, bare of f th rs bo tl heel, nd ha m mbranes bet ee th t es.

GRA E, A rock co is t g esse t ally f crystals f f Lp d mas of q tz.

HABI T Th local ty l a pla t m l t rally l es.

HEM PT t rd b-order of sects, char- ct l by tl poss ss of j ted be k rost d by ha g th f re- g h y tl b l t nd m mb us t th trem ty l re tl y ross h ther Th gro p r es f bugs.

tl ca f tl n d th f rel g d jual l tl g f b rd th sam f

ped

h mol gy Th p ts l h t d ich relat t h th re sa d t be h mologo nd uch p rt g called tl h molog f tl the l d ff re t p la ts tl parts of the fl re h m l g us, d ge l these p t re re- garded as h k gous th)

H M PTERA A rd b l f sects ha (lik th H m p t ra) j ted beak, b t h h th f re- g re th h lly men bra us h lly l th ry Th C cadæ frog h pp rs, d Aph d s, are ll-k mples.

H D, Th off pri g of th m of t d t t

I H EUM E, A f ly f hym pt ro is sects, th m mbers f h h l y th tl bod gg of th sects.

IM O, Th perfect (ge lly ged) reproduct t t f sect.

I E ES, Tl bo g l mal l bl n- h b ta ts of co try g n.

I LO ESCE E, Th mod f rra g m t f tl fl ers of pla ts.

I FU IA A las f m roscop imal ules, so called from th ir ha g g ally bee bserved du f re ct bl m tt rs. Th y co t f g lat us m t l losed d l cat bra th h l p t f h h fur hed tl h t brat g hairs (called l) by ns f h ch th m l l m thro gh th t co y th m t p rt l f th ir food t th fice f tl th

I ECTI s, l ed g sects.

I ER EB I ER EBRA A MALS, Those m ls h h d t possess backb p l colum

LACUNÆ, Spaces l ft among the t sues in some of the lower animals and serving in pl c of vessels f r the c rcul tion of the flu ds of the body

LAMELLATED Furnished with l mellæ or little plates

LARVA (pl LARVÆ) The first co dition of an i isect at its issuing f om the egg when it is usu lly in the form of a grub caterpillar or maggot.

LARYNX, The upper part of the windp pe opening into the gullet.

LAURENTIAN A group of greatly altered and very anci nt rocks hich is greatly devel ped along the course of the St. Laurence wh nce the name. It is in thes that the earl e t known traces of or gan c bodies have been found

LEGUMINOSÆ, An order of plants repre ented by th common peas and beans, having an irr gular flower in which on p tal sta ds up like a wing and the stamens and pistil are encl sed in a sheath formed by two other petals The fruit is a pod (or legum)

LEMURIDÆ, A group of four ha d d an m ls dis t ct from the monk ys and pproaching the in sect orous quadrupeds in some of the r char acters and habits Its members l a the n strils curved r twisted and a cl w inste d of a na l upon the first finger f the h nd hands

LEPIDOPTERA An order f insects ch r ct rised by the p ssess on of a sp ral prob c s, a d of f ur large mo e r l ss caly wings It includ s the well known butterfli s a d m ths

LITTORAL, Inhabiting the seashore

LOESS A m rly dep sit of recent (Post Tertiary) date wh ch occup es a gre t part of the valley of the Rhine

MALACOSTRACA Th h gh r di is on f the Crus tacea, incl ding the ord n ry cr bs, l b ters, hr mps, &c. t gethe w th the oodl ce d sa d h ppers

MAMMALIA Th h ghe t class f an m ls, lud ng

f om the t at (*M mmæ M mma y g' nds*) f the m ther A strik g d ff renc in mbryon c d el pm t has led to the d n f this cla s to

ng a d the y ng p od ed n a ry incom pl te tate The form clud g th g e t p t f the cl ss re called *Plac t l m mals* the latt r or *Aplacental m mmal* l d the mar upi ls nd m n tremes (O n thorhynchus)

MAMMIFEROUS, H v g mammæ teats (*ee* MAM MALIA)

MANDIBLES, in n ects, the firs r upp rm t p r f jaws, wh ch a g n rally sol l b r y b ti g *org ns* In b rds th term is ppl ed t botl j s with th ir horny cov ings. In quadruped the mandible is properly th lower j w

MARSUPIALS, An rd r of Mammalia in hich the young are born in a very compl te tate of de v lopment, nd carried by the moth r whil sucki g in a ve itral pouch (marsup um) such as the kangaroos, opossums, &c. (*s e* MAMMALI)

MAXILLÆ, in insect the second or l er p r of jaws, wh ch are comp sed of se ral j nts a d furi ish l with peculiar jo t d append ges called palp r feelers.

MELANISM The oppos te of albinism an u due de vel pment of colouring material in the skin and its appendag s.

METAMORPHIC ROCKS, Sedimenta y rocks which have undergone alterat gener lly by the ct of heat sub eque tly to th ir deposit a d con

known und r the dei ominat on f hellfish the cuttle-fi h and the c mmon s a ls, h lls, oysters, muss ls, and cockles, m y serve as ex ampl s of th m

MONOCOTYLEDONS r MONOCOTYLEDONOUS l LA TS, Il nts in wh h th eed ends up o ly a ngl seed l af (r cotyledon) hara teri ed by the b senc of c secuti e l y s f ood in th st m (dogen us gr wth) by th ns f the l a es bei g g rally stra ght, and by th p rts f the flowers b ing g ner lly mult ple f three (*E mple gra ses l l es, ch ls, p lms, &c.*)

MORAINES, Th accumulat ons of fragme ts of rock br ught d wn by glac rs

MORPHOLOGY Tl la of f rm or stru ture i de pei de t of fu ct

MYSIS-STA E, A stag in the d l pm nt of certa n cru tac s (prawn) in l l they cl sely re sembl th dults f a g us (My) *belonging to* a l ghtly lo r group

NASCENT Comme ing d vel pment

NATATORY Adapted for the purpo e f s im n g

NAUPLIUS-FORM Th earl t st ge tl d l p n t of many Crust a, pec lly bel g g t tl e l er group I i th tag tl e n m l has a h t l od w th l t t d t ns f a d

cl ps was d scr bed s a dist t n me of Naupl us

NEURATIO Th arra g m t of th ve ns r ner ur s i tl wi g f i ect

NEUTERS, Impe fectly d l ped f al s f c rta n *soci l se ts (ucl as ts d bees)* h h per f m ll the labours of th commu ty H ce th y lso called *worker*

N CTITATING MEMBRANE, A sem tra sparent m m b wh l can be dra cross th y i b rds and reptiles, th r to mod r t th ffects of a

strongl ht or t weep particles of dust, &c., from the urface of the eye

OCELLI, The simple eyes or temmata of insects, usualy tuated the crown of the head between the great compound yes.

ŒSOPHA US, Th gullet.

OOLITIC A gre t series of secondary rocks, so called from the texture of som of ts members, hich ppear to be made p of mass of small gg-lik calcareous bodies.

OPERCULUM, A calcareous plat mployed by many Mollusca t close the perture of their shell. The percular valve of cirripedes are those which close the perture of the shell.

ORBI The bo y ca ity for th receptio of th eye.

ORGANISM, A organised being, whether plant or animal.

ORTHOSPERMOUS, A term pplied t those fruits of the Umbelliferæ hich ha the seed straight.

OSCULANT Forms gro ps ppare tly int rmediate between and connecting othe gro ps are said to be osculant.

OVA, Eggs.

OV RIUM or OVAR (plants) Th lower part of the pistil or female organ of the fl wer co taining the vules or incip t seeds by growth after the other organs of th fl w have fallen, t usually becomes co rted int th fruit.

OVI EROUS, Egg-bearing.

OVULES (of plants) The seeds in the earliest condition.

P CHYDERMS, A group of Mammalia, so called from their thick skins, nd including the elephant, hinoceros, hippopotamus, &c.

P LEOZOIC, The oldest syst m of fossiliferous rocks.

P LPI, Jointed ppendages to som of the organs of the mouth in insects nd Crustacea.

PAPILI EÆ, A order of plants (see LEGUMI OSÆ), The fl ers of these plants are called papilionaceous, or butterfly lik from th fancied resembla ce of th xpanded superio petals to the wi gs of b tterfly

PARASITE, An unal or pla t living po or in, and t th pense of th rganism

P RTHENOGENESIS, The product of living organisms from unimpregnated ggs or seeds.

PEDUNCULA ED, pported po stem or stalk. Th pedunculated oak has ts acorns born po footstool.

PELORIA or PELORISM, Th ppearance of regularity of structure in the flowers of plants which normally bear irregular flow rs.

PELVIS, Th bo y arch t hich the hi d limbs of ert b ate nimals are articulated.

PETALS, The leaves of the corolla, or second ircle of org ns in flow They are usuall of d licat t ture nd brightly col ured.

PHYLLOD OUS, Havi g flatt ned, leaf lik twigs or leafstalks instead of true lea es.

PIGMENT Th colouring material produced generally in th uperficial parts of nimals. The cells secreting t are called pigment-cells

PI TE, Bearing leafl ts ach sid of central stalk.

PISTILS, Th f male organs of fl wer which occupy positio in th ce tre of th ther floral organs. Th pistil is generally di isible int the ary germ n, th tyle and the stigma.

PLACENT LIA, PLA ENT A, or Place tal Mammals, See MAMMALIA.

PLA TI RA ES, Quadrupeds which walk upo the whole sole of th foot, like the bears.

PLASTIC, Readily capable of change.

PLEISTOCEN l cen n, The latest portion of the Tertiary poch.

PLUMULE (plants), The mi ut bud betwee the seed-lea es of newly germinated plants.

PLUTO. c ROCKS, Rocks pposed t have bee produced by gneous actio in th d pths of the earth.

POLLEN Th male eleme t in flowering plants usually fine dust produced by th anthers, which, by co tact th the stigma ffects the fecundatio of the seeds. This impregnatio is brought about by means of tubes (pollen-t be) which issu from the pollen-grains adhering t the stigma, and penetrate through the tissues until they reach the rary

P A DROUS (flowers), Flowers ha ing ma y stamens.

POLYGAMOUS PLANTS, Plants in which som flowers are unisexual and others hermaphrodite. The unisexual (male and f male) flo ers, may be the sam or on differe t plants.

P MORPH c, Prese ting many forms.

P YZO The comm tructure formed by the cells of the Polyzoa, uch as the w ll-known seamats.

PREHENSILE, C pable of grasping.

PREPOTENT Ha ing periority of power

PRIMARIES, The feathers formi g the tip of the wing of bird, and nserted upo that part which represe t the hand of man.

PROCESSES, Projecti g portions of bones, usually for the ttachm t of muscles, ligame ts, &c.

PROPOLIS, A resinous material collected by the hive-bees from th pe ing buds of arious trees.

PROTEAN Exceedi gly ariable.

PROTOZOA, Th lowest gre t di isio of the nimal kingdom. These nimals are composed of g lat inous material, nd show scarcely any trace of distinct organs. Th Infusoria, Foraminifera, nd spo ges, with som other forms, belo g to this di ision.

PUP (pl. PU Æ) The seco d stage in th development of nsect, from which t merges in th perfect (winged) reproduct ve form. I most insects th pupal stag is passed in perfect repose The chrysalis is the p pal tat of butterflies.

RAD CLE, The mi ute root of an embry plant.

RAMUS, O half of th l wer j w in th Mammalia,

The portion which rises to articulate with the skull is called the *ascend ng r m s*

RANGE, The ext nt of country over which a plant or animal is naturally spread *R nge int me* expr sses the d stribution of a species or gr up through the fos l ferous beds of the earth s cru t

RETINA The del cate inn r coat of the eye formed by nervous filaments spread ng from the optic nerve and serving for the perc ption of the im pre s ons produced by l ght

RETROGRESSION Backward development When an animal as it approaches maturity becomes less perfectly org nised than might b e p cted fr m its early stages and known relationships it is said to undergo a *retrog de d velopment* or *meta or phosi*

RHIZOPODS A class of lowly organised animals (Protozoa) having a gelatinous b dy the surface of which c n be pr truded in the form f root l ke pr c sse or filaments which se ve for l comotion and the prehension of food The m st i portant rder i that of the Foramin fera

RODENTS Th gnaw ng Mammalia such as the r ts r bbits and squirrels They are especially ch ract rised by the p ssession of a single pair of ch el like cutting t eth in each jaw betwe n which and the gr nd ng teeth th re s a gr at g p

RUBUS The bramble g nus

RUDIMENT RY Very mp rfectly devel ped

RUMINANTS The gr up of qu d upeds h ch ru minat r chew th cud such as oxen sheep and d They have d vid d h fs and are destitute of fro t teeth in the upper jaw

SACRAL, B l nging t the sacrum or the bone com p ed u u lly of two r more unit d vertebræ to l ch th d s of th pelvis in v rtebrate animals e attacl ed

SARCODE Tl gelatin us mat r al f which the bodies of the low t nim ls (Prot zoa) re comp sed

SCUTELLÆ, The horny pl tes ith h h the fe t of b ls ar g erally m re or less covered pe c lly n fro t

SEDIMENT RY FO MATIONS, Rocks depos ted as sed iments f m wat

SEGMENTS, Th tr ns erse ri gs of wh ch th body of a a ticul t an m l or ann l d comp ed

SE ALS Tl l es r gme ts of the c lyx r ut rm t c velop of n rd n ry flo r Tl y re u u lly g ee b t omet m br ghtly col ured

SEI ATURES Te th l ke th e f saw

SESSILE, N t s pp t d on a t m r footstalk

SILURIAN SYSTEM V ry nc e it ystem f foss l f ro rocks belon g to th e rl r part of the P læo o c r es

SPECIALISATION The s tt g p rt f a particul r g n f rtl e perf rm nce f a p t ular f ct on

SPINAL CO Th ce t l p rt n of th n rv us sy t m i th V rt l rat wl h d sc nds f m th bra throu gh the rel e f tl t l r d gi s off l rly all th r v s to th v us g ns of the body

STAMENS Tl male org ns of flowering plants, st ndi g in a circle with n the petals. They usu ally con ist of a fil ment nd an anther the nth r being tl e essent al part in which the pollen r fecundating dust is formed

STERNUM Th br ast bone

STIGMA Tl e apical portion of the p t l i flo ering pl nts

ase of

fect pistil,
y nd sup-

n.

nction of the

TARSUS (pl TARSI) Th

et n usually
ny
y rg ns f
n or touch

TRACHEA Tl e windp pe or passage for th admis- s n f ir t the lungs

TRIDACTYLE Th ee-fing ed r c mpo ed of three movable part tt l ed t a c mmon ba

TRILOBITES A p ul group f e t t crust ce h t r mbl g th oodl ce in x ternal f rm nd lik s m f tl c p bl f roll ng tl m elve up i to ball Th rem ns ar f u l ly in th l læo o c rocks, a d most bundantly in th e of S l n ag

TRIMORPHIC I nti g th e d st nct forms

UMBELLIFERÆ An d f pla its n h h tl fl s, h h cont in fiv tamens nd pi til with two tyle upp rted up n footst lks h h pring from the t p f th fl r tem d sp ad out l k th w r s of n umbr ll o as to b g all the fl r n th s m he d (*mbel*) ne ly t the same l el (*Examples* parsl y d carrot)

UNGULAT Hoof d quad up ds

UNICELLULAR C ns t g f a ngle cell

bræ wl l co st tut s th ce tr f tl e sk l t nd t tl sam t m p- p t d protect th centr l p rts f the rvous y t m

W oals, The circles or spiral lines in which the parts of plants are arranged pon the axis of growth.

Workers, See neuters.

Zoæa-sta e. The earliest stage in the d velopm t of many of the highe Crustacea, so called from the name of *Zoe* pplied t these young animals whe they were supposed t constit t peculiar genus.

Zooids, I many of th lower animals (uch as the corals, Medusæ, &c.) reproduction takes place tw w ys, namel by means of ggs and by process of budding th or w thout separation from th pare t of the product of the latter which is oft very different from that of the eg. The indi iduality of the pecies is represe ted by the hole of the form produced bet ee t se ual reproductions nd these forms, hich are ppar-ntly indi idual animals, ha been called *zooids*.

THE DESCENT OF MAN

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INTRODUCTION

THE NATURE of the following w rk will be best understood by a bri f account of h w t cam to be written. D ring man ars I col lected notes n th rigin descent f man, with t any inte ti n f p bli l g n th subject, but rath with the d term ti n n t to p blish, as I th ght th t I sho ld thus nly add to th prej d ce gainst my i ws. It seemed to me suffici t to d cat in the first edition of my *Origin f Specie* that by this w k "light w uld be thrown n th rigin f man and his histo and this implies that man must be incl ded w th th game beings in any ge ral con lusi n re pect g his mann of ppearance n this arth N w the case w ars wh lly d ff re t a pect. When turali t lik Carl V t t re to say in his address as Presid nt f th N tional Instit tion f G n (1869) *pe ne en Europe moins os plus te ir la cré ation ndépend nte et d t utes pnec d espece* t is manif t that t l ast a large umbe of naturalists must admit that species are th modified descend t f th pe ci and this especiall h ld good w th th

attention may be directed but these great classe of facts afford as t ppears to m ample and conclu v e id nce in f ou of th principl of gradual ev l ti n Th trong pport d ri ed from the th r argum nts should h we r al ay be kept before the mind

Th sole bject f this wo k is to consid r firstly wh th r man, l ke e ry th r pecies, is descended from some pre-e ting f rm secondly tl manner of his d lopment and thirdly th al f th d ff rences between the so-called race of man. As I sl all confin myself to these po nts, t w ll n t be necessary to d scribe in d tail the d ff re ces between the se ral races—an rm us ubject wh cl has be n full d scussed many al abl w ks. Th l gh ant quity of man has recently been d m nstrated by th labours f h st f m ent m beginni g w th M Bo che de P rthes and this is the ind pe sable bas s f und rstanding hi rigin. I shall, th re f re take this conclus fo granted and m y ref my read rs t tl adm rabl tre tises of S Charles L ll, S J hn Lubbock, and tl rs. N I ll I h occas on t d m re tl an t allud to the am u t f

...

tunat ly are till pposed t l ti m ry f rm

In conseq nce f th w n w ad pted by most naturalists, and whi h w ll ult m t ly as m ry th case be f ll wed b th rs wh are t sci tific, I h bee led t p t together my notes, so as t see h w far th g ral co lusi ns arri ed t m f rm w ks w re pplicabl to man This seemed all th more desirabl as I h d d liberat ly pplied these w t pecies tak n sin ly Wh w confin tt t n t an f rm, w are d pri ed f th w ght arguments deri ed from th n t re f th affinities whi h connect t g th w l gro p f ganisms—their geographical d trib t n in past and prese t times, and tl ir geol gical cess Th h mological tru t re, mbryological d l pm nt, and rud m ntary ans of species remain t be considered wh th t be man any th animal, to which ur

f prim t

This w k contains hardl any rigi al facts in reg wh h draft, th t tl

and co fid ntly been asserted th t man rigin can n be known b t gnorance m re freq tly beg t confid ce than does kn wl edge t th se wh kn w littl and t th se wh kn w much wh so posit l assert that this th t probl m w ll n be sol ed by sci ce Th co cl th t man is th co-d sce d t with oth pec f som anci t, l w and xt nct f rm n t n any d gree n w Lamarck l g g cam to this con l n, whi h has lat l been mai tained by se al min t naturalists and phil soph rs f nstance, by Wallace, Huxl y L ll, V gt,

Lubbock Büchner Rolle &c [1] and e pecially by Haeckel This last naturalist besides his great work *Generelle Morphologie* (1866) has recently (1868 with a second edit in 1870) published his *Naturliche Schopfungsgeschichte* in which he fully discusses the genealogy of man If this work had appeared before my essay had been written I should probably never have completed it Almost all the con clusions at which I have arrived I find con firmed by this naturalist whose knowledge on many points is much fuller than mine Wher ever I have added any fact or view from Prof Haeckel s writings I give his authority in the text other statements I leave as they origi nally stood in my manuscript occasionally giving in the foot notes references to his works as a confirmation of the more doubtful or interesting points

During many years it has seemed to me highly probable that sexual selection has played an important part in differentiatin the races of man but in my *Origin of Species* (this edition p 43) I contented myself by merely alluding to this belief When I came to apply *this view to man I found it indi pensable to* treat the whole subject in full detail [2] Consequently the second part of the present work treating of sexual selection has extended to an inordinate length compared with the first part but this could not be avoided

I had intended adding to the present volumes an essay on the expression of the various emotions by man and the lower animals My at tention was called to this subject many years ago by Sir Charles Bell s admirable work This illustrious anatomist maintains that man is endowed with certain muscles solely for the sake of expressing his emotions. As this view is obviously opposed to the belief that man is descended from some other and lower form it was neces ary for me to consi ler it. I likewise wished to ascertain how far the emotions are expressed in the same manner by the different

I

published by Dr Francesco B rrag bear g in Ital n the t tl of Man m de in th im ge of God was also made n the im ge of the ape

works.

Part One

Descent or Origin of Man

CHAPTER I

THE EVIDENCE OF THE DESCENT OF MAN FROM SOME LOWER FORM

ti ns are ...
ance w th the law wh h p ail w t t lowe anim ls. Again, are th ari ti n the res lt, as f as gn ance permits u to j dg f th m g l causes, and ar th y g rned by th same g n al f ws, as n th case f th gai ms f t nce by corre Lati n, th inh rited ffects f se and dis se, &c.? Is man subject to milar m lconf rmati ns, th esult f arre ted d l pm t f red pl cati n f parts, &c. and does h d play m l e n to som f

Th quire w uld t com to t po tant point, wh th man tends t ase at so pid te, as to l ad to occas nal se re truggles f ex t ce and conseq tly to be ficial ar t wh th body o mind being p ese ed and injuri us es l m nated D th ac pect f m n, wh l t rm m v b ppl ed n ach n and place an tl so th t som fi ally becom t t? W sh ll see th t all th se q ti s, as deed h m re pect t most f th m m t be answ ed th af firm t e, in th sam mann as with th l animals. B t th se al co d tions just ref red to may be con m tly defer ed

f r a t m and we will first see l w far tl e bod ly tru ture f man sh ws traces, m e r less plain, f h s descent from some l w r f rm In ucceed ng chapt rs th me tal pow rs of man n comparison w tl those of the low r animals, w ll b cons dered

The Bodily Struct e f Man It is notori tri t d on th same g n

co ...

So it w th his muscles, ne es, b ... and int rn l scera. The b ain the most im portant f all the gans, f ll ws the same law as sh wn by Huxl y and otl e anat mists B sch ff who s a h til w tn ss, admits that y chi f fis ure and f ld in th bra n of man has ts analogy in th t f th ang b t h period f d l pm nt do

t

ent t ense p ...

perieu nt bien m mes Il ne f t pas e f d'ill ns à et ég d L hom ie est bien pl pr s des ges nth pomorph pa les ca acter nat m ques d ert q e ce -c ne le t lem nt des aut s m mm f es mais mem de ert ns q adru

th h gh mammals ...
b ain and all th part f th body

G h rmend gen d Mens hen, 1868 s. 96 Th co clus ns of this th as ll as thos f Grati let d A by co cerni g th bra will be d scussed by Prof Huxley th ppe dix pag 360

Leç su la Phy 1866 p 890 as q ted by M. Dally *L Ord des Primate et le T form sme*, 1868, p. 29

a
'd
by which th... correspondence

lower ani-
... and to communicate to them certain diseases, as hydrophobia, variola, the glanders, syphilis, cholera, herpes, &c.;[3] and this fact proves the close similarity[4] of their tissues and blood, both in minute structure and composition, far more plainly than does their comparison under the best microscope, or by the aid of the best chemical analysis. Monkeys are liable to many of the same non-contagious diseases as we are; thus Rengger,[5] who carefully observed for a long time the *Cebus azaræ* in its native land, found it liable to catarrh, with the usual symptoms ...

... of
... and cataract in the eye. The younger ones when shedding their milk-teeth often died from fever. Medicines produced the same effect on them as on us. Many kinds of monkeys have a strong taste for tea, coffee, and spirituous liquors: they will also, as I have myself seen, smoke tobacco with pleasure.[6] Brehm asserts that the natives of north-eastern Africa catch the wild baboons by exposing vessels with strong beer, by which they are made drunk. He has seen some of these animals, which he kept in confinement, in this state; and he gives a laughable account of their behaviour and strange grimaces. On the following morning they were very cross and dismal; they held their aching heads with both hands, and wore a most pitiable expression: when beer or wine was offered them, they turned away with disgust, but relished the juice of lemons.[7] An Am...

... these trifling f...

... affected.

Man is infested with internal parasites, sometimes causing fatal effects; and is plagued by external parasites, all of which belong to the same genera or families as those infesting other mammals, and in the case of scabies to the same species.[8] Man is subject, like other mammals, birds, and even insects,[9] to that mysterious law, which causes certain normal processes, such as gestation, as well as the maturation and duration of various diseases, to follow lunar periods ...

... especially during an early embryonic period, occasionally possess some power of regeneration, as in the lowest animals.[10]

The whole process of that most important functio... ...species is ... from the ... the birth ... young Monkeys are born in almost as helpless a condition as our own infants; and in certain genera the young differ

Dr. W. Lauder Lindsay has treated this subject at some length in the *Journal of Mental Science*, July 1871; and in the *Edinburgh Veterinary Review*, July 1858.

[illegible] ... ct fluids by the same chemical re[agent] ...

Naturg[eschichte] der S[äugethiere] von Paraguay, 1830, s. 50.

The same tastes are common to some animals much lower in the scale. Mr. A. Nicols informs me that he kept in Queensland, in Australia, three individuals of the *Phaseolarctus cinereus*; and that, without having been taught in any way, they acquired a strong taste for rum, and for smoking tobacco.

Brehm, *Illustrirtes Thierleben*, B. i. 1864, s. 56. On the ... 105. For ... ments s. ss. 25, 107.

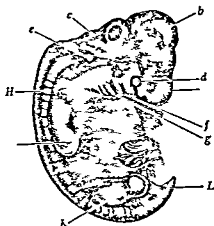
Dr. W. Lauder Lindsay, *Edinburgh Veterinary Review*, July 1858, p. 13.

With respect to insects, see Dr. Laycock, ... *Brit. Assoc.* ... North Am... 05 has re... ... could be added.

... *Quad* ...

... *Cynocephalo* ... *Illust* ... *Cynocephal* ... communia ... *Cynoceph* ... Semper ...

full as much in ppearance from th ad lts, as do our children from th ir f ll grow par ents. It has been urged by so n wnt rs, as an important distinct n, th t w tl man the oung arr at maturit t a much l t age than with an th animal but if w look to the races of manki d which inhab t tropical



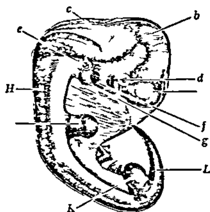


Fig 1 Uppe figure huma mbryo, from Ecker Low figure that of d g, from Bischoff

a. F re-brain, ce bral hemi pheres, &c b. Mid-brain, corpora quadrigemina Hind-brain, cerebellum, medula oblo gata d. Eye Ear f First visceral arch g Second visceral arch H V rtebral columns and muscle in process of developme t Anterior tremities K Posterior tremities L. T il os coccyx

co ora fro wo as the two se es f man mammals. So that the corre po d nce g n ral tructure in the min t tructure of th tissues, n chem cal composition and in constit t n, between man and th high r animals, especially the anthro- l ml ne s xtrem l l se

ry arly period can ... from that of th m mbers of th rt brat k l m At tl period th art ries run in

f rm positi n. At somewh t l t period wh n th tremities are d l ped, th feet f lizards and mammals, as th llustri us n Bae remarks, th wings and feet of b rds, n less than th hand and feet of man, all arise from th same fundam ntal f rm. It is, say Prof Huxl uite in th lat r tages f d l pm nt that th young human being prese ts marked diff rence from th ung pe, whil th latt departs as m ch from th d g in ts d lopm nts, as th man does. Startling as this la t asserti n m y ppear t be t d m nstrably tru "

As som f my read rs m n r ha seen a drawi g f an mbryo, I h gi n on of man and anoth f d g, t abo t th sam arl tag f d lopment, caref lly cop ed from two w ks of nd bted accu acy "

Aft th f rego g tat m nts mad by uch high th rities, t w uld be perfl s o m part to gi a numbe f borrowed d tails,

"This remark is made th respect t Cynocephalus nd the anthropomorph us pes by Geoffroy Saint Hilaire and F C vier *Histoir Nat de M mm fères*, tom. i., 1824

Huxley *M Plac in Nat* 1863, p. 34

M Plac Nat 1863, p. 67

"The human mbry (pper fig) is from Eck *Icone Phy* 1851 1859 tab. xxx. fig 2. This m-bry was t lines l th, so that th dra g is much magnified. The embry of the d g is from Bischoff *Entwi kl g g schichte de H nd Fie* 1845, tab. xi., fig 42 B. This drawing is fi times magnified, th embry being tw ty fi e days old. The internal viscera have bee omitted, nd th terine ppendages in both drawi gs remo ed. I was directed t these figures b Prof Huxley from whose work, *M Place Nat* the idea of gi ng them was taken. Haeck l has also gi n analogous dra ings in his *Schöpf g geschichte*.

shewing that the embryo of man closely resembles that of other mammals It may however be added that the human embryo likewise resembles certain low forms when adult in various points of structure For instance the heart at first exists as a simple pulsating vessel the excreta are voided through a cloacal passage and the os coccyx projects like a true tail extending considerably beyond the rudimentary legs [16] In the embryos of all air breathing vertebrates certain glands called the corpora Wolffiana correspond with and act like the kidneys of mature fishes [17] Even at a later embryonic period some striking resemblances between man and the lower animals may be observed Bischoff says that the convolutions of the brain in a human fœtus at the end of the seventh month reach about the same stage of development as in a baboon when adult [18] The great toe as Professor Owen remarks [19] which forms the fulcrum when standing or walking is perhaps the most characteristic peculiarity in the human structure but in an embryo about an inch in length Prof Wyman[20] found that the great toe was shorter than the others and instead of being parallel to them projected at an angle from the side of the foot thus corresponding with the permanent condition of this part in the Quadrumana I will conclude with a quotation from Huxley [21] who after asking does man originate in a different way from a dog bird frog or fish says The reply is not doubtful for a moment without question the mode of origin and the early stages of the development of man are identical with those of the animals immediately below him in the scale without a doubt in these respects he is far nearer to apes than the apes are to the dog

Rudiments This subject though not intrinsically more important than the two last, will for several reasons be treated here more fully [22] Not one of the higher animals can be named which does not bear some part in a rudimentary condition and man forms no exception to the rule Rudimentary organs must be distinguished from those that are nascent though in some cases the distinction is not easy The former are either absolutely useless such as the mammæ of male quadrupeds or the incisor teeth of ruminants which never cut through the gums or they are of such slight service to their present possessor that we can hardly suppose that they were developed under the conditions which now exist Organs in this latter state are not strictly rudimentary but they are tending in this direction Nascent organs on the other hand though not fully developed are of high service to their possessors and are capable of further development Rudimentary organs are eminently variable and this is partly intelligible as they are useless or nearly useless and consequently are no longer subjected to natural selection They often become wholly suppressed When this occurs they are nevertheless liable to occasional reappearance through reversion—a circumstance well worthy of attention

The chief agents in causing organs to become rudimentary seem to have been disuse at that period of life when the organ is chiefly used (and this is generally during maturity) and also inheritance at a corresponding period of life The term disuse does not relate merely to the lessened action of muscles but includes a diminished flow of blood to a part or organ, from being subjected to fewer alternations of pressure or from becoming in any way less habitually active Rudiments however may occur in one sex of those parts which are normally present in the other sex and such rudiments as we shall hereafter see have often originated in a way distinct from those here referred to In some cases organs have been reduced by means of natural selection from having become injurious to the species under changed habits of life The process of reduction

I of Wyman in *P c ed gs f th Americ Academy f Sciences* vol iv 1860 p 17

[19] O *Anatomy of V rt brates* v l i p 533

[21] *Die G os h rnwind gen des M nschen*, 1868

has done all that can fairly be attributed to it, and when the saving to be effected by the economy of growth would be very small [23] are difficult to understand The final and complete suppression of a part already useless and much

[23] Som good cr t cism n this s bject has been g by M rs. Mun d M art n *Tr nsactions Zoologic l Society* 1869 l. vii p 92.

his *Gener lle Morphologie* u Bd [illegible]

ed ced in size, n which case neithe compen at o eco my can com nt pl y i pe h d f th hypoth si of

R dim ts f ari us muscle ha e bee ob rved m y parts f the human body [25]

th now wh h many animals, especially

bodies f r instance th m scl th f re h ad by wh h th ey brow ar a sed Th *platy ma my ides* wh ch s w ll d l ped n th eck, belo g to th y tem Prof Turn f

i tan t f th *d bd m al* b t i losely all ed to tl *pa iculus* occ rred th proport f b t three pe ce t up-ward f 600 bod h adds, th t th muscl af f rd an cell t ll t ti n f tl t t m nt th t occasi l and rud m tary tru t re are peci ll i bl t ri ti rang m t.

Som f w pe so h th pow f con tracting th pe ficial muscl th scalp and th se m scl re ri bl and par t lly rudim tary nd ti n. M A. d Cand ll has commun ted t m ri nstance f th l g-co ti ed pe t ce h rstance f th pow as w ll as f t un ld l p-m t H h famil wh ch o m m b th p se t head f tl f mily co ld wh th p tch se al h vy books from hi head by th movement f the scalp al ne and he won wag rs by perform g this f at. Hi f th r u cl grandfath r and h tl ree cl l lr n possess the sam powe to the sam un s al d gree Tl is f mily became d ded r i to tw b anches so

prog n tors since m y m k ys ha and freq ently use the powe f *largely mo i g* the scalps up and do n.[27]

The t ns c muscle wh h serv to m ve

nal l in d el pm t at least in f nc

ars and thus di ecti g o tt nt n to-w d th m co ld reco r som power f m m nt by r peated trials. The po er f recti g and directi g the sh ll f th ars to th ar us points f the compass, is no d bt

m y be consi l red ru l m t, togetl w th th ri f ld nd promin n (h l and anti l l t agu and anti tr gu &) wh hi tl e l w anim l t gth n and s pport th ar wh rect, w tl t add g m h to ts w ght Som th s, howe s ppose tl t th carti lag f the sh ll serves to t an m t vibrati s to th aco ti n b t Mr T ynbee [28]

[25] Prof W Tur *Proc ed ng f the Royal Society of Ed nbu gh*, 1866-67 p. 65

Variatio f Animals and Plants nder D mest

[26] See my *E presn f the Emotions M nd A mal* 1872, p 144

[27] Can trini q t Hyrtl. (*A uario dell Soc dei N t alisti*, Mod na 1867 p 97) t the sam effect.

[28] *The Diseases f the E* by J T ynbee F R S 1860 p 12 A distinguished phy l gist, Prof P y inf rms m that h had lat ly bee peri-m ting th fun ti f th h ll f th nd has com to early the sam co lusi as that gi h re.

after collecting all the known evidence on this head concludes that the external shell is of no distinct use The ears of the chimpanzee and orang are curiously like those of man and the proper muscles are likewise but very slightly developed [30] I am also assured by the keepers in the Zoological Gardens that these animals never move or erect their ears so that they are in an equally rudimentary condition with those of man as far as function is concerned Why these animals as well as the progenitors of man should have lost the power of erecting their ears we can not say It may be though I am not satified with this view that owing to their arboreal habits and great strength they were but little exposed to danger and so during ı ı

ı ... to that of those large and heavy birds which from inhabiting oceanic islands have not been exposed to the ...

ı

... can move the head in a horizontal plane so as to catch sounds from all directions It has been asserted that the ear of man alone possesses a lobule but a rudiment of it is found in the gorilla [31] and as I hear from Prof Preyer it is not rarely absent in the negro

The celebrated sculptor Mr Woolner informs me of one little peculiarity in the external ear which he has often observed both in men and women and of which he perceived the full significance His attention was first called to the subject whilst at work on his figure of Puck to which he had given pointed ears He was thus led to examine the ears of various monkeys and subsequently more carefully those of man The peculiarity consists in a littl ... he in ... esent, ... Prof ... Ludwig Meyer more frequently in man than in woman Mr Woolner made an exact model of one such case and sent me the accompanying drawing (fig 2) These points not only project inwards towards the c...

s

rectly in front or behind They are variable in size and somewhat in position standing either a little higher or lower and they sometimes occur on one ear and not on the other They are not confined to mankind for I observed a case in one of the spider monkeys (*Ateles beelzebuth*) in our Zoological Gardens and Mr E Ray Lankester informs me of another case in a chimpanzee in the gardens at Hamburg The helix obviously consists of the extreme margin of the ear folded inwards and this folding appears to be in some manner connected with the whole external ear being permanently pressed backwards In n...



Fig 2 Human Ea modelled and drawn by Mr Wo ln r
a. The proj cti g p nt

the ear is slightly pointed and the margin is not at all folded inwards but if the margin were to be thus folded a slight point would necessarily project inwards towards the centre and probably a little outwards from the plane of the ear and this I believe to be their origin in many cases On the other hand Prof L Meyer in an able paper recently published [32] maintains that the whole case is one of mere variability and that the projections are not real ones, but are due to the internal cartilage on each side of the points not ...

...is minute points or the whole margin is sinuous I have myself seen through the kindness of Dr L Down the ear of a micro-

[30] Prof A Macalister *A nals nd M gaz ne of Nat al History* vol v 1871 p 342.

[31] Mr St George Mivart, *Elem nla y A atomy* 1873 p 396

[32] See ... Messrs Murie and Mivart ... *Transactions of the Zoological Society* ... 1869 pp ... 90

[33] Über das D... *A h f r Path Anat* ... 1871 p 485

cephalous idiot, n wh ch th re is a projecti on the outsid of the h lix and n t n th inward folded edge, so th t this point can ha e n t f rm pex f th ear Ne rthe-

f th mammal an series namely in tl e Mo o- trem t and mars p als, and n some few of tl h gl mamm ls, as in the walrus. But i man, tl Quadrumana, a d mo t tl mam mals, t xi ts, as i adm tted b all anat mi ts, as a m re rud m t, alled th sem l r f ld[25]

The sense f m ll s f th high t mportance t the gre t r umber f mammals—to some

to be most p —

of th cartila through t the wh le xt nt f the margin, t w uld ha e co red fully e- third of th wh l ar Tw case h been communicated to m on in N rth Am rica, and the the in England n which th ppe margin is t t all f lded wards, b t pointed, so that t l sely resembles th po ted ear of an rdinary q adruped n o th In ne of these cases, which was that f y ung child, th f th compared th ar with th drawing which I h gi n[24] f th ar of a m nkey th *Cynopithec g* and sa tl t th ir tlines are cl sel *similar* If th se two cases, th margi had been f lded wards in th rmal mann an nw rd project n must ha e bee f rmed. I m y add that n tw th cases th thn till remains som what pointed, altho gh th margin f th ppe part of th ar is n rmall f lded inward —in of them, how narrowly Th f l lowing woodcut (fi 3) an accurate copy of photograph f th fœtus f an rang (kindly se t m by D N tsch) in which t may be seen h w diff re t th pointed thn of th ear t this period from ts adult cond ti n, wh t bears a close g n ral resemblance to that f man. It is d t th t th f lding er of th tip of ch an ar unless t changed greatl during ts furth d l pm t, w uld give rise to poi t projecting inwards. On th wh le, t till seems to m probabl that th po ts in q esti are in som cases, both in man and pes, estig f f rm co dit n

Th nictitating membrane, third lid, th ts accessory muscl and th tru tures, especiall w ll d loped in b rds, and is of m h f ncti al mportance to th m, as t can be pidly drawn across th wh l ball It f und in som reptil and amphib- ans, and in ce tain fishes, as in sharks. It fairly w ll d loped in th tw l w di si ns

Fig 3 Fœtus of orang Exact copy of phot graph, sh g th f rm of th ear t this arly ge.

as th ruminants, in warning tl m f dan er to oth rs, as the Carni ra, in findi g th prey to th rs, gain, as th wild boar f both purpose comb ed B t the sense f m ll is f extremely slight serv ce if an e n to the dark col ured races f men, n wh m it is much more highly d l ped than in th white and civilised races.[26] N rth less t

[24] *The Expressio of the Emotions*, p. 136.

[25] R. K x, *G eat Art sts nd A atomists* p 106 Th rudim t ppare tly is som hat large N groes nd Australians tha in Europeans, see Carl V gt,

[26] perim ts, nd pro ed that N groes nd Indians could recognise persons in th dark by their od ur D W Ogle has mad som curi us bserv tions the connect betwee th pow of sm ll nd th col uring in t of th m cous m mbra of th lfactory regi as w ll as f th kin f th body I ha e, therefore poke in the text of th da k col ured races ha ing fine sense of m ll tha the white races. See his pape *Medico-Ch gical Transactions* Lond n, l. liii., 18 0 p. 276

does not warn them of danger nor guide them to their food nor does it prevent the Esquimaux from sleeping in the most fetid atmosphere nor many savages from eating half putrid meat. In Europeans the power differs greatly in different individuals as I am assured by an eminent naturalist who possesses this sense highly developed and who has attended to the subject Those who believe in the principle of gradual evolution will not readily admit that the sense of smell in its present state was originally acquired by man as he now exists He inherits the power in an enfeebled and so far

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animals which have this sense highly developed such as dogs and horses the recollection of persons and of places is strongly associated with their odour and we can thus perhaps understand how it is as Dr Maudsley has truly remarked [37] that the sense of smell in man is singularly effective in recalling vividly the ideas and images of forgotten scenes and places

Man differs conspicuously from all the other

that of a woman The different races differ much in hairiness and in the individuals of the same race the hairs are highly variable not only i
thus
quite
tufts
the h
rudiments of the uniform hairy coat of the lower animals This view is rendered all the more probable as it is known that fine short, and pale coloured hairs on the limbs and other

I am informed by Sir James Paget that often several members of a family have a few hairs in their eyebrows much longer than the others so that even this slight peculiarity seems to be inherited These hairs too seem to have their representatives for in the chimpanzee and in certain species of Macacus, there are scattered hairs of considerable length rising from the naked skin above the eyes and correspondin to our eyebrows similar long hairs project from the hairy covering of the superciliary

month is thickly covered offers a more curious case It is first developed during the fifth month on the eyebrows and face and e pecially round the mouth where it is much longer than that on the head A moustache of this kind was observed by Eschricht [38] on a female fœtus but this is not so surprising a circumstance as it may at first appear for the two sexes generally

of the fœtal body are the same as in the adult, but are subject to much variability The whole surface including even the forehead and ears, is thus thickly clothed but it is a significant fact that the palms of the hands and the soles

coat of hair in those mammals which are born hairy Three or four cases have been recorded of per ons born with their whole bodies and faces thickly covered with fine long hairs and this strange condition is strongly inherited,

the lanugo of a fœt

by a surgeon to a ho pital for children have their backs covered by rather long silky hairs and such cases probably come under the same head

It appears as if the posterior molar or wisdom teeth were tending to beco ne rudimen

[37] *The Physiology and Pathology of Mind* 2nd ed 1868 p 134

[38] Eschricht, Über di R ichtu g d Ha am menschlich Körper *Muller* [illegible] *Anat und Phy* 1837 s 47 I hall ften ha e to r f to this ry curi us p per

[39] Paget, *Lectures on Surgical Pathology* 1853 vol. i p 71

[40] 47

rece ed dr gs f both fr m l rus

tary in th more ci ilised races of man. These teeth are rathe smalle than the ther m lars, as is likewise the case with th correspo di g teeth in th chimpanzee and o ang and th y have nly tw separate fang Th y d n t cut thro gh the gums till about th se enteenth year and I ha bee assured that th y are much m re liable t decay and are ari r lost than the th teeth b t this d nied by som mi t d nti ts. Th y are also much more l al l to ary both tru t re and
l

erally sound th y also diff from the th r molars in size, less than n th C casian races.[42] Prof Schaaffh usen accounts f thi d ff re ce bet ee th races by the post ri d ntal porti of th j w be ng al sh rt ned in those th t are ci lised[44] and this h rt ning may I presume, be ttributed t ci lised m n hab tually feeding on soft, cooked food and thus usin th j w l ss. I am nf rmed by M Brace that t is becoming quit common practice th United States to rem som of the m lar teeth f children, as the j w does t grow larg gh f th perfect d l p m t f th rmal umber[45]

W th respect to th alin ntary canal, I ha e met with an account f nly si gl rud m nt,

actually m re than thrice as l g as the whol body[46] It som times p od ced to a l g grad ally taperi g po t, d is sometim constri ted in parts. It ppears as if n conse q ce f changed d t hab ts, th circum had becom m h h rt ed ari ani mals, th rm f rm ppe dag being l ft as a

rudim penda, small Can trin nas co man It is occas o ally quite absent, or again i la g ly de l ped Tl e passage is som tim s compl tely closed for half r two-tl rds of its l gth with the terminal part consi ti g of a fl tt ned sol d expansio In the rang thi ap-
l

th ca se f d ath, f wh cl fact I h e lat ly heard tw instan e this s d e to small hard bod es, s ch as seeds, nt ring the passage,

hook lik process f bo compl ted b a band f ligam nt. *Dr Struth rs,*[49] wh l as losely tt ded to the ubject, has n w sh wn th t this pecul arity is som times nh rited, as t has occurred in a f the and in less than f ut f his se n children. Wl n present th gre t nerv in ari bly passes through t and thi cl arly indicate that t the h mo l gu and rudim nt f the pra-condyl d f ram f th l w r animals. Prof Turn r tim tes, as he inf rms m th t t occ rs n about pe cent f recent skelet ns. B t f th occasi nal d l pm nt f this tru t re in man s, as seem probabl d e to reversion, it is a ret rn t a ry anci nt t t of thi gs, be cause in th high Q adruman t abse t.

[42] Dr W bb, *Teeth in M and the Anthropoid Apes*, as q ted by D C Cart Blak in *Anthropological Review* July 1867 p. 299

[43] On n. *A atomy f V ertebrates* ol. iii., pp. 320 21 nd 325

[44] On th Prim ti F rm of the Skull, Eng translat., in *Anthropological Review* Oct., 1868, p. 426

Prof M tegazza write t m *from Fl rence*, tha h has lately bee tudying th last m lar teeth in the diff re t races f man, d has com to th same conclusio as that gi in my t t, viz., that in th higher civilised races they ar the road to ards trophy liminat n.

[45] Owen, *Anatomy f V ertebrates*, ol. iii., pp 416 434, 441

tio t this peculiar tructure in man see his *Great Art rts nd Anatomists*, p. 63. See also importa t mem ir this process by D Grube in th *Bulle- t de l'Acad Imp de St. Péter bourg* tom xii., 1867 p. 448

There is another foramen or perforation in the humerus occasionally pre ent in man which may be called the his ro- of a an mais It is remarkable that this perforation eems to have been present in man much more frequently during ancient times than recently Mr Busk [1] has collected the following evidence on this head I rof Broca noticed the perforation in four and a half per cent of the arm bones collected in the Cime tiere du Sud at I aris and in the Grotto of Orrony the contents of which are referred to the Bronze period as many as eight humeri out of thirty two were perforated but this ex traordinary proportion he thinks, might be due to the cavern having been a sort of family vault Again M Dupont found thirty per cent of perforated bones in the caves of the Valley of the Lesse belonging to the Reindeer period whilst M Leguay in a sort of *dolmen* at Argenteuil observed twenty five per cent to be perforated and M I runer Bey found twenty six per cent in the same condition in bones from Vaureal Nor should it be left un noticed that M I runer Bey states that this condition is common in Guanche skeletons It is an interesting fact that ancient races in this and several other cases more frequently pre sent structures which resemble those of the lower animals than do the modern One chief cause seems to be that the ancient races stand somewhat nearer in the long line of descent to their remote animal like progenitors

In man the os coccyx together with certain other vertebræ hereafter to be described though functionles a a tail plainly represent this part in other vertebrate animals At an early embryonic period it is free and projects beyond the lower extremities as may be seen in the drawing (fig 1) of a human embryo Even after birth it has been known in certain rare and anomalous cases [52] to form a mall external rudiment of a tail The os coccyx is short, u ually including only four vertebræ all anchylose l together and these are in a rudi mentary condition for they consist with the exception of the basal one of the centrum alone [53] They are furnished with some mall mu cles one of which as I am informed by Prof Turner has been expressly described b Theile as a rudimentary repetition of the ex tensor of the tail a mu cle which is so largely developed in many mammals.

The spinal cord in man extend only as far downwards as the last dor al or fir t lumbar vertebra but a thread like structure (the *filum terminale*) runs down the axi of the sacral part of the spinal canal and even along the back of the coccygeal bone The upper part f this filament as I rof Turner inform me is un doubtedly homologous with the pinal cord but the lower part apparently con i ts merely of the *pia mater* or vascular inve ting mem brane Even in this case the os coccyx may be said to posse s a vestige of so important a structure as the pinal cord though no longer enclosed within a bony canal The following fact for which I am al o indebted to Prof Turner shews how clo ely the os coccyx cor re ponds with the true tail in the lower ani mals Luschka has recently discovered at the extremity of the cocc

c u Krause and Meyer to examine the tail of a monkey (Macacus) and of a cat in both of which they found a similarly convoluted body though not at the extremity

The reproductive ystem offers vari us rudi mentary tructures but these differ in ne important re pect fro

a

t o cx an l represented in the their l v a mere rudiment Neverthele s, the occurrence of such rudiments i as difficult to explain n the belief of th separate creation of each pe cies, as in the foregoing cases. Hereafter I hall have to recur to the e rudiments, and hall shew that their p es nce generally depends merely on inheritance that is, on parts acquired by one x ha ing b en partially tran mitted n fœtu be fro

[51] Mr St Geo g Mi rt T act I h l Soc 186 p 310
O th Ci e f G l It T n rt u f the Int atio l C g f P h l l l ol gy Th rd 1869 p l 9 Ir f Wyn tl s l t ly h (F th In l P pot l body M m 1871 p 20) th t this perf ratio prese t th ty pe ce it f t l ren n fro c t i u l n th West t ted St tes d n Fl rda It freq th ace rs tl gro
[52] tref ges has l t ly collected th l e n th b t P e d C S t (q 186 1868 p 6 I 1 1810 Fl d l ted l

ncer d Arch f Zoolog Decr lst 18 1)
[53] O tl V t f I mb 1849 p 114

t th th I ıll ın thı place only gı some ın tance of such rudiments. It ı w ll kn wn that n th males of all mammals. ludı man, rudimentary mammæ exist. These ın se ral n.tances ha e becom w ll d l ped and ha lded cop u pply of milk. Th ır esse tıal ıd ntıt ın th t o se s lık wise sıewn by their occası nal mpath tic enlargement ın both durı an ttack of th m asles. Th sıcula pros at ca, wh h has been observed man mal mamm ls, n w unı ll acknowledged t be th h m lo u f th

those mammals wl ch th tru f mal ut rus bifurcates, f th males of the e th sıc la likewise bif re tes.[34] Some oth rudım tary tructure belonging t th reprod t e s t m m ht ha been h re add ced [35]

Th bearı f th three gre t classes of fact now given ıs unmıtakabl B t t would be perıl us full t recapitulate th lın of argum t gı n ın d taıl ın m Orıgı f Spe cıe Th h m l gıcal con truct n of tl wh le fram ın th m mbers f th sam lass ıs ıntellıgıbl ıf w admıt th descent from comm pro ııt t geth w th th r bsequent adapt tı t dı ersified cond tions. On an th w th similarıt of patt rn bet een th hand of man m nk y th foot of h rse the flıppe l seal, th wing f a bat, & tt l plıcable [36] It sci ntıfic planat on t assert that th ha e all bee f rmed th sam d al plan. W th respect t d l pm t, w can learly und tand th princıpl f arı t perven ıng t rath lat mb period and be nh rıted t correspondı g period h w

ıt s th t tl e mbrı os of wonderfull d ff rent f rms sh uld till retain, m re r less perfectl th truct re of th r common pro ıtor No the xplanat n has r been gı n f th marv llous fact that the mbrı os of man, d g seal, bat, reptıl &c., can t first hardl be dı tı gu shed from each the In ord r to und rstand the exı ter ce of rud m tary organs, we ha onl to ı pose that a f rm r progenıt r possessed tl parts ı t on ı a pe fect st t and that und hanged hab ts l bl they became gre tl reduced tl from sımpl d suse or throu h the natural select n of those ndı duals wh h w re l a t ncumbered w th a pe fl us part, aided by th the means pre usl ınd cated

Th w an und rstand how t has come to pass that man and all oth rt brate anımals ha been constru ted on the sam general mod l, wl th y pass through the sam arl st ges of d lopm nt, and wh tl retaı certain rud m nts ın comm n. Consequ tl w ght frankl to admit th r communit of descent to take any th r w ıs to adm t

wh anımal series, and consıd r the d nce d rı ed from theı affinıtı or classification. theı geographical d trıbution and geol gıcal s cces n. It ıs nl our n tural pre d ce

t tructure and d lopm t of man, and oth mammals, should h e bel ed that ach was th wo k f separat act of cre tı n.

Leuckart ın Todd *Cyclopæd of A atomy* 1849– 2, ıl p. 141 I ma this orga ıs ly from three t sıx lı es le gth, b t lık so ma y other rudıme tary part t ıs arıable d l pme t as ll as ın theır hara ters.

[35] thıs bject, Ow n, *Anatomy f Vertebrate* ol ııı pp. 6 3, 67 6, 06.

[36] Prof Bıanconı ın rece tly p blıshed work, ıllustrated b admirable ngra ıngs (*La Theorı Darwı na et la cr ation d nd pendente* 1 4) takes ours t show that homological structures, ın the horse nd othe cases, ca be fully plaıned mechanical principles, accordance th theır uses. No one has she so ll, h w admırabl, uch struc ures are adapted for theır final purpose nd thıs lap tıon can, as I I lıeve be plaıned throu h natural selection. I consıderıng the ıng of bat, he brings forward (p. 1) hat ppears t m

(t use A gust Comt words) mere metaphysıcal principle namel, the preserv tıon ın ıts t grıt of the mammalian nature of the anımal. I only f w cases does he ıscuss rudımı ts, nd then onl, those part hıch are partıall, rudıme tary uch as the little hoof of the pı nd ox, hıch d not touch the ground these he ho clearly t be of service t the anımal It ıs nfortunat that he dıd not consıde uch cases as the mın t teeth, which ne er cut through the jaw ın the ox, or the mammæ of male quadrupeds, or the wings of certaın beetles, xısting und the soldered ıng-covers, or the estıges of the pıstıl nd stamens ın rıous flow rs, nd many the such cases. Although I gre tl admire Prof Bıanconı work, et the belief w held t, most naturalı ts seems t m left nshaken, that homological tructures are inexplicable on the principle of mere adaptation.

There is another foramen or perforation in the humerus occasionally present in man which may be called the inter condyloid This occurs but not constantly in various anthropoid and other apes [50] and likewise in many of the lower animals It is remarkable that this perforation seems to have been present in man much more frequently during ancient times than recently Mr Busk [1] has collected the following evidence on this head Prof Broca noticed the perforation in four and a half per cent of the arm bones collected in the Cime tiere du Sud at Paris and in the Grotto of Orrony the contents of which are referred to the Bronze period as many as eight humeri out of thirty two were perforated but this ex traordinary proportion he thinks might be due to the cavern having been a sort of family vault Again M Dupont found thirty per cent of perforated bones in the caves of the Valley of the Lesse belonging to the Reindeer period whilst M Leguay in a sort of *dolmen* at Argenteuil observed twenty five per cent to be perforated and M Pruner Bey found twenty six per cent in the same condition in bones from Vaureal Nor should it be left un noticed that M Pruner Bey states that this condition is common in Guanche skeletons It is an interesting fact that ancient races in this and several other cases more frequently pre sent structures which resemble those of the lower animals than do the modern One chief

In man the os coccyx together with certain other vertebræ hereafter to be described though functionless as a tail plainly represent this part in other vertebrate animals At an early embryonic period it is free and projects beyond the lower extremities as may be seen in the drawing (fig 1) of a human embryo Even after birth it has been known in certain rare and anomalous cases [52] to form a small external rudiment of a tail The os coccyx is short usually including only four vertebræ all anchylosed together and these are in a rudi mentary condition for they consist with the exception of the basal one of the centrum alone [53] They are furnished with some small muscles one of which as I am informed by Prof Turner has been expressly described by Theile as a rudimentary repetition of the ex tensor of the tail a muscle which is so largely developed in many mammals

The spinal cord in man extends only f

a v e sacral part of the spinal canal and even along the back of the coccygeal bones The upper part of this filament as Prof Turner informs me is un doubtedly homologous with the spinal cord but the lower part apparently consists merely of the *pia mater* or vascular investing mem brane Even in this case the os coccyx may be said to possess a vestige of so important a structure as the spinal cord though no longer enclosed within a bony canal The following fact for which I am also indebted to Prof Turner shews how closely the os coccyx cor responds with the true tail in the lower ani mals Luschka has recently discovered at the extremity of the coccygeal bones a very pe culiar convoluted body which is continuous with the middle sacral artery and this discov ery led Krause and Meyer to examine the tail of a monkey (Macacus) and of a c t in I th of which they found a similarly convoluted body though not at the extremity

The reproductive system offers various rudi mentary structures but these differ in ne important re pect from the foregoing cases Here we are not concerned with the vestige of a part which does not belong to the species in an efficient state but with a part efficient in the one sex and represented in the other by a mere rudiment Nevertheless the occurrence of such rudiments is as difficult to explain on the belief of the separate creation of each spe cies, as in the foregoing cases Hereafter I shall have to recur to these rudiments and I shall shew that their presence generally depends merely on inheritance that is on parts acquired by one sex having been partially transmitted

M St Geo g M rt T ct ns I h l Soc 186 p 310
O i l C v of G b lt T ns ctio u f th Inte al o l C g f I h tori 1 h ol gy Third n 1869 p 159 Prof Wym n h s l t ly h (F rth An l Repo t I body M m 1871 p 20) th t this perf rat n is p ese t

this ub ect. R n d C Sci t fq 186 1868 p 6 I 1840 Fl ch I I ted a l u

h ll N derl d t h f Zoolog D ember 18 1)
O U N t f I mb 1849 p 114

of the lower animals th ugh th facts are copious no gh with respect to th latt r So regard to mental qualities, their transmissi n is manif st in our d gs, horses, and other domestic animals. Besides pecial tastes and habits, gen ral int lligence courage bad and good temper &c., are certainly transmitted. With man w see similar *facts* n *almost* e ry famil and w now know thro gh the d mirable labours f M Galton,[12] that g nius which implies a wond rfull compl combination of high faculties, t nds t be inh rited and, th th hand, t *is too certain* that insanit and d t riorated me tal powers likewise run families.

W th respect to th causes of ariab lit w are al cases err gnora t but w can see that in man as in th l animals, th y stand in som relation to th conditions to which each pecies has been e posed, during se ral generations. Domesticated animals ary more than those in stat of nature and this is pparentl d to th di rsified and changing nature of th co d ti ns t wh ch they h been subjected. In this respect th di re t races of man resembl d mesti ated animals, and so d th individuals f th same race wh inhab tin ry wid area, lik that of Am rica. W see th infl nce of di sified conditi ns in th m re civilised nati ns for the m mbers belo ging t different grades of rank, and f llowing diff rent occupati ns, prese t greate rang of charact than do th m mbers of barbarous nati ns. B t th uniformit of sa age has oft n been exag g rated, and som cases can hardl be said to exist. It is, ne rtheless, an rror to speak of man, if w look on to th conditi ns to which h has been exposed, as far more d mesticated than an other animal. Som sa a races, such as th Au tralians, are not xposed to more di rsified cond t ons than are many pecies which ha wid range. In anoth and much more important respect, man diff rs widel from an trictl domesticated animal for his breeding has long been co trolled, ther by m thodical o un conscious selecti n. No race or body of men has been so compl tely subj g ted by othe m n, as th t certai ndi duals sh uld be preserved and thus unconsci usly selected from som l w xcelling in utility to thei mast rs. N b certai mal and f male ind d als l t ll p cked out and m tched,

cal selecti n f t i asserted that many tall men were reared n th llages inl abited by th grenadiers and th r tall wi es. In Sparta, also, a form of select n was f llowed f it was acted that all children should be x amined sh rtly aft birth the w ll formed and g rous being preser ed, the others left to perish.[13]

If w consid r all the aces of man as f rming a singl speci s, his ran e enorm us b t som separat races, as th Am ricans and Pol n sians, ha ry wid ranges. It a w ll-kn wn law that wid ly rang pecies are much more variable than species with re tricted ranges and th variabil ty of man may with m re truth be compared with that of wid l ranging pecies, than with that of d mesticated animals.

N t nl does ariab lit ppear to be in d ced in man and th low animals by the

pro eme t of mankind. H saw likewise that wealth ofte becks the proper action of sexual selection. H thus writes

With kine nd horses, Kurnus, we proceed
By asonable rules, and hoose br ed
For profit and ncrease at y pric
Of sound stock without defect or vice
But, th daily mache that we make,
The price is everything for money sake,
Men marry women ar marriag gi en
The kurl or ruffian, that wealth has thriven,
M y match his f pri g with the proud st ous.
Thus everythi g is mix d, noble nd base!
If then ut rd manner form, and m nd,
Y find degraded, motley kind,
Wonder no mor my friend! the cause is plain.
And to lament the consequenc is vain.

(*The Works of J Hookham F ere*, vol. ii., 1872, p. 334.)

Hereditary Genius an I quiry nto its Law and Consequences, 1869

M B tes remarks (*The Naturalist on the Amazons*, 1863, ol. ii., p. 159) with respect to the Indians of the same South American tribe no l of them were ll similar in the shape of the head one ma had an oval visage with fine features, and anothe was q te Mongolian in breadth and prominence of heek, spread of nostrils, and obliquity of yes.

Blumenbach, *Treatises on Anthropology* Eng. translat., 1865, p. 205.

CHAPTER II

ON THE MANNER OF DEVELOPMENT OF MAN FROM SOME LOWER FORM

IT is manifest that man is now subject to much variability No two individuals of the same race are quite alike We may compare millions of faces and each will be distinct There is an equally great amount of diversity in the proportions and dimensions of the various parts of the body the length of the legs being one of the most variable points [1] Although in some quarters of the world an elongated skull and in other quarters a short skull prevails yet there is great diversity of shape even within the limits of the same race as with the aborigines of America and South Australia—the latter a race probably as pure and homogeneous in blood customs and language as any in existence —and even with the inhabitants of so confined an area as the Sandwich Islands [2] An eminent dentist assures me that there is nearly as much diversity in the teeth as in the features The chief arteries so frequently run in abnormal courses that is has been found useful for surgical purposes to calculate from 1040 corpses how often each course prevails [3] The muscles are eminently variable thus those of the foot were found by Prof Turner[4] not to be strictly alike in any two out of fifty bodies and in some the deviations were considerable He adds that the power of performing the appropriate movements must have been modified in accordance with the several deviations Mr J Wood has recorded[5] the occurrence of 295 muscular variations in thirty six subjects and in another set of the same number no less than 558 variations those occurring on both sides of the body being only reckoned as one In the last set, not one body out of the thirty six was found totally wanting in departures from the standard descriptions of the muscular system given in anatomical text books A single body presented the extraordinary number of twenty five distinct abnormalities The same muscle sometimes varies in many ways thus Prof Macalister describes[6] no less than twenty distinct variations in the *palmaris accessorius*

The famous old anatomist, Wolff[7] insists that the internal viscera are more variable than the external parts *Nulla particula est quæ non aliter et aliter in aliis se habeat hominibus* He has even written a treatise on the choice of typical examples of the viscera for representation A discussion on the *beau ideal* of the liver lungs kidneys &c. as of the human face divine sounds strange in our ears

The variability or diversity of the mental faculties in men of the same race not to mention the greater differences between the men of distinct races is so notorious that not a word need here be said So it is with the lower animals All who have had charge of menageries admit this fact and we see it plainly in our dogs and other domestic animals Brehm especially insists that each individual monkey of those which he kept tame in Africa had its own peculiar disposition and temper he mentions one baboon remarkable for its high intelligence and the keepers in the Zoological Gardens pointed out to me a monkey belonging to the New World division equally remarkable for intelligence Rengger also insists on the diversity in the various mental characters of the monkeys of the same species which he kept in Paraguay and this diversity as he adds is partly innate and partly the result of the manner in which they have been treated or educated [8]

I have elsewhere[9] so fully discussed the subject of Inheritance that I need here add hardly anything. A greater number of facts have been collected with respect to the transmission of the most trifling as well as of the most important characters in man than in any

[1] *Investigations in the Military and Anthropological Statistics of American Soldiers* by B A Gould 1869 p 256

vol 1844

[4] *Transactions of the Royal Society of Edinburgh*, vol xxiv pp 175 189

[5] *Proceedings Royal Society* 1867 p 544 also 1868 pp 483 524 There is a previous paper 1866 p 229

[6] *Proc R Irish Academy* vol x 1868 p. 141

1 78 rt u p 217

tion, vol ii chap xii.

of the l w r animal th ugh the facts are cop us gh with respect to th l tt r So in r ard to m tal qualities, their transmiss on

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W h m w see similar f ct i alm y

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W th re pect to th se f ariab lity we ar all case ry gn t b t w an e that man as the l animals, th y tand in som rel tion to th co dit n to which ach pec has been posed d g se ral g ti s. D m t cated animal ary m re than those n tat I n tur and thus ppare tly d to th d fied and changi g t re f th co d t ns t wh ch th y h bee bjected In thus pect th d ff re t ace f man resembl d m t ted animals, and so d th di d als f th sam race wh nhab ting ery w d ar a, l k that f Am rica. W e th infl nce f d sified condit tl m re ci ıl sed t f th m mb rs b l gi g t d ff rent grades of ank, and f ll g d ff rent occupat ns, prese t gre te ang f characte than d th m mb f barbarous ti ns. B t th unif rmity f sa ag has ft be n xag g ted and som case can hardly b said to xist It s, n rth l ss, an ro t speak of man, f look nly to tl cond ti ns to which h has bee exposed as far m re d mesticated th an th animal Some sa ag aces ch as tl A t alians, are n t exposed to m re d rs fied co d t ns than ar many peci whi h h w d ange. In an th nd m ch m mportant respect, man d ff rs w d ly from any tri tly d m ti cated animal f his breed g has n l g

served and th s unco sc usly selected trom som l w cell ng i til ty to th i mast rs. N r h e ce t male and f m le nd v d ls f f i lly p ked t and m tched

th grenad rs and th tall wi s. In Sparta, lso f m f select n was f ll ed f it was acted th t all children sl o ld b mi ed sh rtly aft r birth the well f rmed and vig rous being preser ed, the oth rs l ft to perish [12]

If we conside all the ace of man as f m g s gle peci s, h an e e rm s b t some separ te ac s, as th An ricans and P ly ans, h ry w de rang s. It w ll kn wn law that w d ly r ging spec s are m h m re ariabl th n speci with re tricted ange d the ariab l ty of man m y with more t th be compared w th th t f w d ly ra g g peci s, than w th th t f d m ticated animals.

Not nly does ri b l ty ppear to be n d ced in man and the l w animals by the

H thus writ

With l ne nd hor es K rnus w proceed
By aso ble ules nd hoo b eed
For pr f t nd ner at y pric
Of so nd stock without defect or vice.

M y match his ff pri g with the proudest ac
Thus everyth g is mix d, oble nd bas !
If then utw d m nner form, nd m nd,
Y find us degraded, motley kind,
W nder no mor my friend! the us plo n.
And to lament the consequenc va

(*The Work of J Hookham F er* ol. ii., 18 2, p 3..4.)

Hereditary Genius I quiry ito its La nd Consequences 1869

M B tes remarks (*The Nat alist on the Amazons*.

Blume bach *T eat se Anthr pology* E g translat., 1865 p 205

same general causes but in both the same parts of the body are effected in a closely analogous manner This has been proved in such full detail by Godron and Quatrefages that I need here only refer to their works [14] Monstro ities which graduate into slight variations are like wise so similar in man and the lower animals that the same classification and the same terms can be used for both as has been shewn by Isidore Geoffroy St Hilaire [15] In my work on the variation of domestic animals I have attempted to arrange in a rude fashion the laws of variation under the following heads — The direct and definite action of changed con ditions as exhibited by all or nearly all the individuals of the same species varying in the same manner under the same circumstances The effects of the long continued use or disuse of parts The cohesion of homologous parts The variability of multiple parts Compensa tion of growth but of this law I have found no good instance in the case of man The effects of the mechanical pressure of one part on an other as of the pelvis on the cranium of the infant in the womb Arrests of development, leading to the diminution or suppression of parts The reappearance of long lost charac ters through reversion And lastly correlated variation All these so called laws apply equal ly to man and the lower animals and most of them even to plants It would be superfluous here to discuss all of them [16] but several are so important that they must be treated at con siderable length

The Direct and Definite Action of Changed Conditions —*This is a most perplexing sub* ject It cannot be denied that changed condi tions produce some and occasionally a con

may be urged on the other side at least as far as the innumerable structures are concerned which are adapted for special ends There can however be no doubt that changed conditions induce an almost indefinite amount of fluctuat ing variability by which the whole organisa tion is rendered in some degree plastic.

In the United States above 1 000 000 sol diers who served in the late war were meas ured and the States in which they were born and reared were recorded [1] From this aston ishing number of observations it is proved that local influences of some kind act directly on stature and we further learn that the State where the physical growth has in great meas ure taken place and the State of birth which indicates the ancestry seem to exert a marked influence on the stature For instance it is established that residence in the Western States during the years of growth tends to produce increase of stature On the other hand it is certain that with sailors their life delays growth as shewn by the great dif ference between the statures of soldiers and sailors at the ages of seventeen and eighteen

results namely that they did not relate to climate the elevation of the land soil nor even in any controlling degree to the al un dance or the need of the comforts of life This latter conclusion is directly opposed to that arrived at by Villerme *from the statistics of*

lower orders within the same islands, or be tween the inhabitants of the fertile volcanic and low barren coral islands of the same ocean [18] or again betv een the Fuegians on the eastern and western shores of their country where the means of subsistence are very dif

precise result Dr Beddoe has lately proved that, with the inhabitants of Britain residence

Godr n *De l'E pèce* 18.9 t m *l rr* 3 Q t f *U i té de l E pece H m* e 1861 Also

(1868) pu is cu *M l e x A* H lay mu h t ss, in th case f plants, on the nature of the soil.

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I B g I see Elph nst n *s History f Ind* vol. i p 324

in t wns and certain occ pat o s h e de- t r ting aff e ce on h ght and he infers t certain t nt nh rited

t x — m l co d t prou e —

nasm h as th 1 gs and — I to activity und a l w t mpe ture and the h and kin d h gh n [30] It was fo m rl th ght th t th col r f th skin and th charact f th hair w re determined by light h t and lth gh t can hardly be d med th t som ffect is thu p od ced al most all bservers now agree that th ffect has bee ry mall en aft xpo ure dur in, many ges. But th ubject will be m re prope l discussed wh n w tre t f th dif f re t aces f mankind W th ur d m t animals th re are ground to bel g th t cold and damp directl affect th growth f th hair b t I h t m t w th any d ce on this head in th case f man.

Effects f th ncr as d U d D sus of P rts—It w ll kn wn th t use tre gth ns th m scl in th di d al, and compl te di se th d tru ti n f th prope ry weak ns th m Wh th y is d troyed th pti erv ft becom trophied Wh n an art ry is tied th late al chann ls increase t nl in diam t but in th thickn ss and tre gth f th ir co ts. Wh n n kidn y ceases t act from disease, th th increase ize and doe d bl w k. B crease t f thi kness, but l gth from carry g gre t w ght [31] Diff re t occupa-

miss I in th lat war w re l ng by 0 217 f an in h than those f th sold rs, th gh th

sail rs w re on an a rage horter men whilst th arms w re sh rt by 1 09 f an in h, and th ref re t f proporti n, short n rel ti t th less r h gl t. Th shortn ss f th arms i pparently d to th i great r use and i an un pected re lt b t sail rs chiefly use th i arms n pull ng and n t n upporting w ghts. W th sail rs, the g rth of tl d f l ptl f th n t p are g w

— Pa guas Indians t s ccessi g — ha ing passed n arly th wh le h in anoes, with tl r l w r trem t s m t l ss. Othe writ rs h come to a m lar co l si n in anal g us ases. Accordi g to Cranz [34] wl o l ed f a l g time w th th E quim ux, Tl n t s bel v th t nge- uit and d t rity n seal-c tchi g (tl r high t art and rt e) i hereditary there s is reall som thi g in t, f th son of a cel b ted seal-catch will dist guisl him self th gh h lo t hi f the in childhood B t th case t i m ntal ptitud quite as m h bod ly tructure wh ch ppears to I

— cause Th t th y are g rall mall r n re- fi ed and ci ilized m n than in hard w king m sa g s, ce tain. B t w th sa ag s, a M H rb rt Spencer[35] has remarked th

M mo Anthropological Society ol. iii.

Domestication, ol. ii. pp 97-300 II J ger Ube das La g sthum der Knoch n, *Jen ische Zeitschrift,* B II ft.

I vestigations, & by B A. G uld 1869 p. 288.

[33] *geth er ro P gu y* 1860 s. 4

H story f G eenland, E g translat. 1 67 L

1853, p. 209 ler ii.

and it can hardly be doubted that this is due

and engravers are liable to be short sighted whilst men living much out of doors and especially savages are generally long sighted [29] Short sight and long sight certainly tend to be inherited [30] The inferiority of Europeans in comparison with savages in eyesight and in the other senses is no doubt the accumulated and transmitted effect of lessened use during many generations for Rengger[31] states that he has repeatedly observed Europeans who had been brought up and spent their whole lives with the wild Indians who nevertheless did not equal them in the sharpness of their senses The same naturalist observes that the cavities in the skull for the reception of the several sense organs are larger in the American aborigine than in Europeans and this probably indicates a corresponding difference in the dimensions of the organs themselves Blumenbach has also remarked on the large size of the nasal cavities in the skulls of the American aborigines and connects this fact with their remarkably acute power of smell The Mongolians of the plains of northern Asia according to Pallas have wonderfully perfect senses and Prichard believes that the great breadth of their skulls across the zygomas follows from their highly-developed sense

that from continually breathing a

rarefied atmosphere they have acquired chests and lungs of extraordinary dimensions. The cells also of the lungs are larger and more numerous than in Europeans These observations have been doubted but Mr D Forbes carefully measured many Aymaras an allied race living at the height of between 10 000 and 15 000 feet and he informs me[34] that they differ conspicuously from the men of all other races seen by him in the circumference and length of their bodies In his table of measurements the stature of each man is taken at 1000 and the other measurements are reduced to this standard It is here seen that the extended arms of the Aymaras are shorter than those of Europeans, and much shorter than those of Negroes The legs are likewise shorter and they present this remarkable peculiarity that in every Aymara measured the femur is actually shorter than the tibia. On an average the length of the femur to that of the tibia is as 211 to 252 whilst in two Europeans measured at the same time the femora to the tibiæ were as 244 to 230 and in three Negroes as 258 to 241 The humerus is likewise shorter relatively to the forearm This shortening of that part of the limb which is nearest to the body appears to be as suggested to me by Mr Forbes a case of compensation in relation with the greatly increased length of the trunk The Aymaras present some other singular points of structure for instance the very small projection of the heel

These men are so thoroughly acclimatised to their cold lofty abode that when formerly carric eastern plai by high wag a frightful Forbes fou survived during served that they still inherited their characteristic peculiarities But it was manifest even without measurement that these peculiarities had all decreased and on measurement, their bodies were found not to be so much elongated as those of the men on the high plateau

seen by consulting Mr Forbes's mem From these observations, there can I think, be no doubt that residence during many gen

[29] It is a s re inf rior t distin t v sion f the H r f this to b th ord nary ange of to the le gth f the v ss l and the h ight f the ma ts

[30] *The Variation of Animals and Plants under Domestication* ol i p 8

[31] S geth ere zu I g y 8 10 I ha had good oppo tun ties f r bse v g the e t rd y po f rl t the I gia is See als Lawr nce (L sa lec rg nd v l iabl body the cau of h rt ght, *C'est le t l as d de pre*

[33] Prichard *Physical History of Mankind* o tl utho ty f Bl m b h 1841 p 311 f r the st tem nt by P ll 1844 p 407

[33] Quoted by Prichard *Researches into the Physical History of Mankind* l v., p 463

[34] Mr Forbe 1 11 p per is now publ led n th *Journal of the Ethnological Society of London*, n w se es, ol ii 1870 p 193

erations t great l ti n t nds, both di rectl and indirectly to ind ce inh rited modificati ns in th proporti ns f th body[22]

Alth gh man may n t ha been much modified during the latt sta_ges f his xist ence thro h th increased decreased use of parts, th facts now gi en shew that his liability in this respect has n t been lost and w positi ly kn w that th sam law hold good with th l animals. Conse q tl w m inf r that wh n at rem te poch th prog nitors f man w re n transi tional stat and w re changing from quad ruped into b peds, n tural selecti n w ld probably h bee greatly aided by th in herited ffects of th increased d minished use of the diff re t parts of th body

Arrest of Dev lopment.—Th re is a dif f rence between arrested d l pm t and arrested gro th, f parts n th f rm tat contin to grow whilst till retaining thei early conditi n. Vari us m nstrosit es com und this head and som as l ft palate are known t be occasi nall inh rited. It will suffice f purpose to ref t th arrested brain-d lopm nt of m crocepl alo d ots, as described in V t m moir[23] Th kulls are small and th con l ti ns f th b ain are les complex than in rmal m n. Th fro tal sinus, th projecti th eye-brows, is larg ly d l ped and th j w are prognath to an *ff y t* d gree so th t these idiots som wh t resembl th l w t pes of manki d Th int llig ce and most of their m tal faculties, are xtrem ly feebl They cannot acquire th pow f peech, and are wh ll incapabl f prolonged attenti n, b t are m h gi to imitati n. Th y are food bef re ati g it. On di t is described as oft n using his m th i aid of his hands, *whilst hunti g f l ce.* Th y are oft n filthy in th hab ts, and ha e no sense of decency and se eral ases ha been publ shed of th r bod es be ng remarkably hairy[24]

Reversio.—Man of th cases to be h re gi n, m ght l e been trod ced und r th last h ading When truct re i arre ted in ts d l pm t, b t till continu s growi g unt l t cl sel resembl s a correspo d g struct re in som l w r and adult m mber of th sam group, t m y in sense be con sid red as case f re rsi n. The l w m m bers in a group gi u som d a h w the comm n pro nit r was probably constructed and t s hardly cred ble that compl part, arre ted t an early phase f embry ni de-lopm nt, sh ld go growing so as ulti mat l to perf rm ts prope fun ti n, unl ss t had acq red ch power d ring som earl r tat f exist nce, wh n the prese t e cep-ti al o arrested truct re was normal. The simple brai of a microcephal us id ot, in as far as t resembles th t f an pe may in this sense be said to ffer case of re ersion.[25]

[24]Prof Laycock ums p the character of brute-like id ts by calling th m *theroid Journal of Mental Science, July 1863* D Scott (*The D af nd D mb*, 2nd ed., 18 0 p 10) has ft bserved th imbeciles m lling their food See this sam bject, and the hairiness of id ts, D Maudsley *Body and M nd*, 1870 pp. 46-51 Pinel has also gi en triking case of hairiness in an idiot.

[25] I my *Variation f Animal nder Domestication* (ol. ii., p. 5) I ttrib ted th not ry are case of pernum rary mammæ in wom to re rsi n. I was led to this as probable conclusion, by the additional mammæ being generally placed ym m trically th breast and more especiall from ne case in which singl ffic t mamma oc-

ture or trees. W are thus reminded f th d light sh wn by almost all bo n climbing trees and this again reminds h w lambs and kids, riginally alpin animals, del ght to frisk any hillock, h w small. Idi ts also resemble th low animals som th respects thus se ral case are recorded of their carefully sm lling ry m thful of

[22] D Wilck ns (*Landwirthschaft. Wochenblatt* No. 10, 1869 has lately p blished int re ting ssay she ing how domestic animals, which h in mountainous regions, ha their frames modified.

[23] *Mémoires sur les Microcéphales*, 1867 pp. 50, 125, 169 1 1 164-198.

p. 56, for case gi by D Hand side, in hich tw brothers xhibited this peculiarity see also

There are other cases which come more strictly under our present head of reversion Certain structures regularly occurring in the lower members of the group to which man belongs occasionally make their appearance in him though not found in the normal human embryo or if normally present in the human embryo they become abnormally developed although in a manner which is normal in the lower members of the group These remarks will be rendered clearer by the following illustrations

In various mammals the uterus graduates from a double organ with t o [illegible] s [illegible] i [illegible] p [illegible] f o having a slight internal fold as in the higher apes and man The rodents exhibit a perfect series of gradations between these two extreme states In all mammals the uterus is developed from two simple primitive tubes, the inferior portions of which form the cornua and it is in the words of Dr Farre by the coalescence of the two cornua at their lower extremities that the body of the uterus is formed in man while in tho e animals in which no middle portion or body exists the cornua remain ununited As the development of the uterus proceeds the two cornua become gradually shorter until at length they are lost or as it were absorbed into the body of the uterus The angles of the uterus are still produced into cornua even in animals as high up in the scale as the lower apes and lemurs

Now in women anomalous cases are not very infrequent in which the mature uterus is furnished with cornua or is partially divided into two organs and such cases according to Owen repeat the grade of concentrative development attained by certain rodents Here perhaps we have an instance of a simple arrest of embryonic development with subsequent growth and perfect functional development for either side of the partially double uterus is capable of performing the proper office of gestation In other and rarer cases two distinct uterine cavities are formed each having its proper orifice and passage [39] No such stage is passed through during the ordinary development of the embryo and it is difficult to believe though perhaps not impossible that the two simple minute primitive tubes should know how (if such an expression may be used) to grow into two distinct uteri each with a well constructed orifice and passage and each furnished with numerous muscles nerves glands and vessels if they had not formerly passed through a similar course of development as in the case of existing marsupials No one will pretend that so perfect a structure as the abnormal double uterus in woman could be the result of mere chance But the principle of reversion by which a long lost structure is called back into existence might serve as the guide for its full development even after the lapse of an enormous interval of time

Professor Canestrini after discussing the

pap r by D Bart l in *Reichert and du Bois Reymond A h* [illegible]

[illegible] pa i n f C ratod h h s provided w th a tr ul t d l y ays o b th side of a ce tr l chain f bo t r m n great d fficulty in a lm tt g that six r m r d gits n e side or o both id m ght r p r through e- ver t I m inf rm d by D Zout e n that the I a as n eco d f a u n ha g tw nty fo r fin s id t ty f u t I w ch efly led t the co lu th t th [illegible]

[illegible] n e pl d tl e d ed tu of n y I *rmat on der D m t l* why I n place l ttle rel ce th er ndel [illegible]

oy [illegible] o I iore Geoff y St H la B t t pre nt t is th saf t co rs t g p lt g tl th idea that tl re is y r k ti t t tl development f supernum ra y l g t t d r rs n to s me lo ly orga zed p r ge t f m n.

[39] Dr A Farre w ll k rt l the *Cyl p d f A tomy d Phy siology* l 1859 p 612 O *t tomy f I t br t* l 1868 p 68 l rof ss T rn *Ed b gh M d al J rn l* F bru ry 1865

forming, and van us analogous cases, ar n es t the same conclusi n as that just g en. H adduces anoth nstance n th case of the malar bone [a] which, in some f the Quadrumana and oth r mammals, n rmall consists of tw port ns. This is t cond ti n in the human fœtus wh n two m nths old and through arrested d lopm nt, t som times remains thus man wh n adult, m re pe call in th low progn th u races. H nce Canestrini concl des th t som anci nt progenitor of man m t h had this bo n mall di ided int tw port ns, which aft wards, becam f sed tog th I man th fro tal bon consists of single p ece b t in the mbryo, and in children, and in almost all the lowe mammals, t consists of two p eces separated b distinct suture This suture occasionall persists m re ess di ti tl in man aft maturit and m re freq tl in ancie t than in recent crania, especiall as Canestrini has observed, in those xhumed from the Drift, and belo gin t th bra h cephalic t pe Here agai h comes to th sam concl si as in th analogous case of the malar bones. In this, and th nstances presentl t be gi n, th cause of anci t races pproaching th low animals in ce tain charact rs m re freq ntl than d th mod rn races, ppears t be th t th latt tand t som hat gre t distance in th long lin of desce t from their arl semi human pro nit rs.

Various oth anomal es in man, more less analo ous t th f rego g, h been ad anced b diff re t thors, as cases of re so b t these seem not littl d btful, f w h to desce d extrem f low n th mammalian series, before we find such structures normally present.[a]

In man th cani teeth are perfectly f fici t nstrum nt fo mast t on. But th ir tru anin cl aract as O n[a] remarks, is ind ated b th conical f rm of the crown, which t rminates n an obtuse po t, is con ex o tward and fl t ub-co a e w thin, at the base f whi h urface th re is a feeble promi n nce Tl com al f rm is best pressed in th M lanian races, especiall th Australian. The canin is more deeply mplanted and b tro g fan than th incisors. N rth less, this tooth no lo ge serves man as a special w pon f t aring hi n m es r prey t m th ref re as far as ts proper function is concerned be consid red as rudim ntary In ry larg collecti n of human skulls some ma be found as Haeck l[a] observes, w th tl cani teeth project con d rabl be ond t th rs in th same mann as n th an thropom rphous pes, b t n a less degree In these cases, pen paces between th teeth n th o w are l ft f th reception of th c o n f w are th anci t kulls which ha been examined compared t recent skulls, t is an int resti fact that in t least three case th canines project largel and n th N ul tt w th are pok n of as norm us.[a]

Of th anthropomorphous pes the m l s alo ha thei canines full d loped but

[a] ... malar bones in se ral huma ubjects nd ce ta pes he cannot conside this disposi io of the parts as mpl accide tal. Anothe pape on this same nomal has bee p blished b D Sa otti he Gazetta delle Cliniche Turin, 1 1 where he says tha traces of the division ma be d tected in 1 per ce t of adult skulls he also remarks th more freque tl occurs in prognathous kull ... of the Aryan race ha in others See also G Delorenzi on he same bject Tre nove casi d omalia dell osso malare Torino, 18 2 Also, E. M rse ... Sopra una rara nomalia dell' osso malare M dena, 1 ... d more rec tl Gruber ha ri pamphlet the di ision of this bone I give hese ref rences because reviewer without an grounds or scruples, has thrown oubts on my statements.

[a] A hole series of cases is gi by Isidore Geoffroy St Hilaire Hist. des Anomalies t m, iii, p. 437 A reviewer (Journal of Anatomy and Physiology ... p. 366) blames me much for ot ha g discussed the umerous cases, which have been recorded, of various parts rrested their de elopment. H sa that, accordi t my theory ery transient condition of an organ, during ts developm nt, is not ly means t nd, b t nce was nd tself This d es ot seem t m necessaril t hold good. Wh hould ot ariations occur duri earl period of d lopm t ha ing no relatio parts, hich ha no relatio t forme tat of ... t nce occur t ear peri d, as w ll as during maturit

[a] Anatom f Vertebrates, ol iii, 1868, p. 323.

[a] Generelle Morphologie 1866, B ... d

[a] C. V t Lect re M Man, translat, 1864 p. 1 1

[a] Carter Blake jaw from La N lett Anthropological Review 1867 p. 29a. Schaaffhausen, ibid., 1868, p. 426.

degree in the considerably fact of which I have been assured that women sometimes have considerably projecting canines is no serious objection to the belief that their occasional great development in man is a case of reversion to an ape like progenitor He who rejects with scorn the belief that the shape of his own canines and their occasional great development in other men are due to our early forefathers having been provided with these formidable weapons will probably reveal by sneering the line of his descent For though he no longer intends nor has the power to use these teeth as weapons he will unconsciously retract his snarling mu cles (thus named by Sir C Bell) [6] so as to expose them ready for action like a dog prepared to fight

Many muscles are occasionally developed in man which are proper to the Quadrumana or other mammals Professor Vlacovich [7] examined forty male subjects and found a muscle called by him the ischio pubic in nineteen of them in three others there was a ligament which represented this muscle and in the remaining eighteen no trace of it In only two out of thirty female subjects was this muscle developed on both sides but in three others the rudimentary ligament was present This muscle therefore appears to be much more common in the male than in the female sex and on the belief in the descent of man from some lower form the fact is intelligible for it has been detected in several of th lower animals and in all of these it erves exclusively to aid the male in the act of reproduction

Mr J Wood in his valuable erie of paper [8] has minutely described a vast number of muscular variations in man which resemble normal structures in the lower animals. The muscles which closely resemble those regularly pre ent in our nearest allies, the Quadrumana, are too numerous to be here even pecified In a single male subject having a strong bodily frame and well formed skull no less than seven muscular variations were observed all of which plainly represented muscles proper to various kinds of apes This man for instance had on both sides of his neck a true and powerful *levator claviculæ* uch as is found in all kin ls of apes and which is said to occur in about one out of ixty human subjects [9] Again this man had a pecial abductor of the metatarsal bone of the fifth digit, such as Professor Huxley and Mr Flower have shewn to exist uniformly in the higher and lower apes I will give only two additional cases the *acromio-basilar* muscle is found in all mammals below man and seems to be correlated with a quadrupedal gait [10] and it occurs in about one out of sixty human subjects. In the lower extremities Mr Bradley [11] found an *abductor ossis metatarsi quinti* in both feet of man this muscl had not up to that time been recorded in mankind but i always present in the anthropomorphous apes The muscles of the hands and arms—parts which are so eminently characteri tic of man—are extremely liable to vary so as to resemble the corresponding muscles in the lower animals.[12] Such resemblances are either perfect or imperfect yet in the latter case they are manife tly of a transitional nature Certain variations are more common in man and others in woman without our being able to a ign any reason Mr Wood after describing numerous variations makes the following pregnant remark

Notable departures from the ordinary type of muscular structures run in grooves or direction which must be taken to indicate some unknown factor of much importance to a comprehensive knowledge of general and scientific anatomy [13]

[6] *The Anatomy of Expression* 1844 pp 110 131

[9] See ... Macalister in *Proceedings Royal Irish Academy* ... 1868 p 124

[10] ... *Journal of Anatomy and Physiology* No ... 1871 ...

... *Zoological Society* ...

the scale are numerous in the Lemuroidea.

... the foot &c

[11] The R Dr Haughton ... (*Proc R Irish Academy* June ... 1864 p 15) a remarkable case ... *flexor pollicis longus* ... This remarkable ... man ... possess th ...

Th t th s unkn n facto s e r t n to a f rm r t te f t ce m y be admitted as n th h h t d g ee p b bl [14] It qu te n cre acc n less an bee o g et c co ect n b tw tl m On th th hand if m n i d scended fr m some pe like re t re al d a on can be assigned why c rt m scl sh ld n t s d d ly reappear fte n t r l f m y th usand g t ons, n the sam man e as with h rse as a d m l d rk-col red stripe dd nly ppear n the l g a d h ld rs afte n te l f h ndreds, m p bably f th an l of g e at s. Th n s ca f e c n a so d sce t f man from som lo r f n m an unmistak bl mann r

Correlated *Va tion* —In man, as n tle l we an n ls i any structures are so in t mat ly l ted tl t wh n o part rie so do s anotle w tho t our l ci g able in m st case to ass gn a y reason We c m t s y wl th r tl e e part g rn tle tl r or wh tl e b th ar go rned by son e earl er de l ped pa t. Vari s m n tro iti s, as I Geoff y pe tedly n t are tl us int mately l H l g tru ture e p r r mark u dep rt f m th i pr p r type tl ey al n t alw y m tate tl ose f th l g a d so co r h l r Tl

re i nished th corn m y b said t ep se t, rud m t y co d t tl am g ts n rm l tat n tai mammals. Some parts wh h rud me t ry man, as th coccy both se s, d tl m mm th mal sc re alw y p nt wh l t th rs s h as th p acondyl d f am n o l oc as lly ppe d th f m ght h bee t od ced d tl h ad f n Th se se l re rs ry tru t as w ll as th tr tly d m tary es, al th

and v P fe so Schaaff en fi t drew tt t nt th l t n ppare tly xi ti g between a m sc lar f ar e and th t gly p ed p a-ob t l ridge whi h are so hara te ist f th l rac of na B d tl ri t s wh cl c n be g o ped

cu au o f r t ig ce th y appe to e w tl t y ti g c se It can, howe b sh n that l a t ns wl tl on s t g f l gl t d d al d ff ces, o f t gly m ked d al rupt d ti n f t t e d p d m ch more n th co t t t f tl g m than n th nat e f th nd t ns to l ch t l as b n b jected [16]

Rate *f* *Inc* *ase* —C l d p pul t h

o tw l e y ar At tl f m t tl

1864 p 138) iat th *fl or pollicis to gu* rem k bl from th ir rel t t th sam muscl

ffi tly marked m er h t m y b co si lered as proof d mpl f th Dar p ncipl f re er n, law of he ta ce, thus departm t of nat m cal sci nce.

der Domest atio Se th mem bl *F y the P nciple f P p latio* by th Re T Malthus, l. 1826 pp 0 517

present population of the United States (thirty millions) would in 6 7 years cover the whole terraqueous globe so thickly that four men would have to stand on each square yard of surface The primary or fundamental check to the continued increase of man is the difficulty of gaining subsistence and of living in comfort We may infer that this is the case from what we see for instance in the United States where subsistence is easy and there is plenty of room If such means were suddenly doubled in Great Britain our number would be quickly doubled With civilised nations this primary check acts chiefly by restraining marriages The greater death rate of infants in the poorest classes is also very important as well as the greater mortality from various diseases of the inhabitants of crowded and miserable houses at all ages The effects of severe epidemics and wars are soon counterbalanced and more than counterbalanced in nations placed under favourable conditions Emigration also comes in aid as a temporary check but with the extremely poor classes not to any great ext nt

ha

actu y less in barbar u than in civilised races We know nothing positively on this head for with savages no census has been taken but from the concurrent testimony of missionaries and of others who have long resided with such people it appears that their families are usually small and large ones rare This may be partly accounted for as it is believed by the women suckling their infants during a long time but it is highly probable that savages who often suffer much hardships and who do not obtain so much nutritious food as civilised men would be actually less prolific I have shewn in a former work[58] that all our domesticated quadrupeds and birds and all our cultivated plants are more fertile than the corresponding species in a state of nature It is no valid objection to this conclusion that animals suddenly supplied with an excess of food or when grown very fat and that most plants on sudden removal from very poor to very rich soil are rendered more or less sterile We might therefore expect that civilised men who in one sense are highly domesticated would be more prolific than wild men It is also probable that the increased fertility of civilised nations would be

come as with our domestic animals an inherited character it is at least known that with mankind a tendency to produce twins runs in families[59]

Notwithstanding that savages appear to be less prolific than civilised people they would no doubt rapidly increase if their number were not by some means rigidly kept down The Santali or hill tribes of India have recently afforded a good illustration of this fact for as shewn by Mr Hunter[60] they have increased at an extraordinary rate since vaccination has been introduced other pestilences mitigated and war sternly repressed This increase however would not have been possible had not these rude people spread into the adjoining districts and worked for hire Savages almost always marry yet there is some prudential restraint for they do not commonly marry at the earliest possible age The young men are often r

l r from her parents With savages the difficulty of obtaining subsistence occasionally limits their number in a much more direct manner than with civilised people for all tribes periodically suffer from severe famines At such times savages are forced to devour much bad food and their health can hardly fail to be injured Many accounts have been published of their protruding stomachs and emaciated limbs after and during famines They are then also compelled to wander much and I was assured in Australia their infants perish in large numbers As famines are periodical depending chiefly on extreme seasons all tribes must fluctuate in number They cannot steadily and regularly increase as there is no artificial increase in the supply of food Savages when hard pressed encroach on each other territories and war is the result but they are indeed almost always at war with their neighbours They are liable to many accidents on land and water in their search for food and in some countries they suffer much from the larger beasts of prey Even in India districts have been depopulated by the ravages of tigers

Malthus has discussed these several checks but he does not lay stress enough on what is probably the most important of all namely

[58] 'Variation of Animals and Plants under Domestication,' vol ii pp 111 113 163

[59] Mr Sedgwick, 'British and Foreign Medico-Chirurgical Review,' July 1863 p 170

[60] 'The Annals of Rural Bengal,' by W W Hunter 1868 p 259

nfanticid pecially f fem l nfant and th habt f procuri g b t n. Tl p ac tices w p l m y q art rs f th w ld and nf ticd seem f rme ly t l e p ailed as Mr M Lenn n[62] has h w n a till m tens seal Tl se p act ce ap- pear t h rrgi ted n g recogn g the d ffi ulty r tl r th mposs b lity of pporting all th i fant th t b rn. L ce t ss m lso b added t th f re g ing checks but tl doe n t f ll from fail m ans f s b ist ce th gh th t reaso t b h tl t som cas (as in J pan) t has been t t nally co r ged as m an f keeping d wn th p p lat n. If look back t an trem ly rem te epoch, b f m l ad rri ed t th d gnity f manhood h w ld h been gu ded m re by ist t and l ss by aso than are th l t sa ag t tl pre t t m Our arly m l m prog nit w ld t h p ac

Tl re uld ha bee n prud t l t t from m rri g and th sex w ld h f ly nited t an arly g H ce th p g nit rs f man w uld h t ded t m reas p dly b t heck s f som k d th pe od l co tant m t h k pt d wn th n mb s m re se rel than th n t g sa ag s. Wl t th prec t re f tl se heck s w e an t sa any m re th n w th m t th anim l W kn w th t h and cattle, h l are n t tr m l p l fi an mals, wl first t rned loose So th Am a, ased t an n rr t Tl l phant th l est breed f ll kn rn nimals, w ld m f w tl sa d ar tock th h l w ld Th ase f ry pec f m nk y m t b

self th ref comp lled t re- t od ce — f rm of tl l ta tal thod y f hi h h ppe rs to be q t iconsc us,— nd t trod as sc f

assert bey nd this — — t

prod t n the w ld h se and catt Am ca, w s t fir t in a y sens bl d gr e cre sed th t as cl d st ct becam fully tocked th sam power was diminished No d bt, in this se d in all th many checks co r d diff r t heck s under dif f t m ta c pe iodical d arth de-

— —

N t l S le tio —W have now se th t *man ar ble in bod* d mind and tl t th iat s re ind ced th r dire tly indir ctly by the sam g n ral ca ses, a d bey th me g al l s, as w th th l r im l Man ha p e d w d ly e th face f tl arth d m t h be n xp sed, d ing his incessa t m g t o [63] to the n o t d fied co d ti The inhab tant f T rr d l Fu g th C p f Good H p an l Tasmania i th on h m sph re and f th t g o th th r must have passd th gh many cl m t s, a d chan ed th r h b ts many time bef th y ea l ed th ir prese t h m [64] Th early p g t f m m t lso h t nded hk ll oth animals, t ha i sed bey d th m n f sub te ce th y m st, th f re oc as n lly h been p sed to struggle f x t- ce d conseq ntly t th gid law f nat u l lect B efi l an t ns of all k d will th th occa lly h bit all l bee p se ed and inj es l m ted I d tref t st gly m ked d t ns f t t hi h occ nly t l g te ls f t m b t t m re d d al d ffe W kn w f tance tl t th m scle f r h d d feet wl ch d t u po f m m t, are habl hk th se f th l w r an m l [65] *lo ce sant ar b lit H th* n the

th ppos te d f th sam ind vidual.

present population of the United States (thirty millions), would in 657 years cover the whole terraqueous globe so thickly, that four men would have to stand on each square yard of surface. The primary or fundamental check to the continued increase of man is the difficulty of gaining subsistence, and of living in comfort. We may infer that this is the case from what we see, for instance, in the United States, where subsistence is easy, and there is plenty of room. If such means were suddenly doubled in Great Britain, our number would be quickly doubled. With civilised nations this primary check acts chiefly by restraining marriages. The greater death-rate of infants in the poorest classes is also very important; as well as the greater mortality, from various diseases, of the inhabitants of crowded and miserable houses, at all ages. The effects of severe epidemics and wars are soon counterbalanced, and more than counterbalanced, in nations placed under favourable conditions. Emigration also comes in aid as a temporary check, but, with the extremely poor classes, not to any great extent.

There is great reason to suspect, as Malthus has remarked, that the reproductive power is actually less in barbarous, than in civilised races. We know nothing positively on this head, for with savages no census has been taken; but from the concurre[illegible] f g r [illegible] may be partly accounted for, as it is believed, by the women suckling their infants during a long time; but it is highly probable that savages, who often suffer much hardship, and who do not obtain so much nutritious food as civilised men, would be actually less prolific. I have shewn in a former work [18] that all our domesticated quadrupeds and birds, and all our cultivated plants, are more fertile than the corresponding species in a state of nature. It is no valid objection to this conclusion that animals suddenly supplied with an excess of food, or when grown very fat; and that most plants on sudden removal from very poor to very rich soil, are rendered more or less sterile. We might, therefore, expect that civilised men, who in one sense are highly domesticated, would be more prolific than wild men. It is also probable that the increased fertility of civilised nations would become, as with our domestic animals, an inherited character: it is at least known that with mankind a tendency to produce twins runs in families.[19]

Notwithstanding that savages appear to be less prolific than civilised people, they would no doubt rapidly increase if their numbers were not by some means rigidly kept down. The Santali, or hill-tribes of India, have recently afforded a good illustration of this fact; for, as shewn by Mr. Hunter,[20] they have increased at an extraordinary rate since vaccination has been introduced, other pestilences mitigated, and war sternly repressed. This increase, however, would not have been possible had not these rude people spread into the adjoining districts, and worked for hire. Savages almost always marry; yet there is some prudential restraint, for they do not commonly marry at the earliest possible age. The young men are often required to shew that they can support a wife; and they generally have first to earn the price with which to purchase her from her parents. With savages the difficulty of obtaining subsistence occasionally limits their number in a much more direct manner than with civilised people, for all tribes periodically suffer from severe famines. At such times savages are forced to devour much bad food, and their health can hardly fail to be injured. Many accounts have been published of their protruding stomachs and emaciated limbs after and during famines. They are then, also, compelled to wander much, and, as I was assured in Australia, their infants perish in large numbers. As famines are periodical, depending chiefly on extreme seasons, all tribes must fluctuate in number. They cannot steadily and regularly increase, as there is no artificial increase in the supply of food. Savages, when hard pressed, encroach on each other's territories, and war is the result; but they are indeed almost always at war with their neighbours. They are liable to many accidents on land and water in their search for food; and in some countries they must suffer much from the larger beasts of prey. Even in India, districts have been depopulated by the ravages of tigers.

Malthus has discussed these several checks, but he does not lay stress enough on what is probably the most important of all, namely

[18] 'Variation of Animals and Plants under Domestication,' vol. ii. pp. 111-113, 163.

[19] Mr. Sedgwick, 'British and Foreign Medico-Chirurg. Review,' July, 1863, p. 170.

[20] 'The Annals of Rural Bengal,' by W. W. Hunter, 1868, p. 259.

ocal organs, which in th pes are used f r ttering anou signal-cries, or as in o e genus, musical cad nce b t in man the closel similar ocal rgans h become ad pted through the inherited ffects of use fo th tterance of rt culat langu

Turning n w to th n are t alli of m n, and th ref re t tl best represe tati es f ur arly pro nit rs, we find th t the hands of the Quadruman are con tructed n th sam general pattern as our wn, b t are far less perfectly ad pted f r d rsified uses. Their hand d not serv f locom ti n so w ll as th feet f d g as m y be seen in ch m nk ys as th himpanzee and orang, wl ch walk the t margins f the palms, n th knuckles.* Thei hands, h w are ad mirabl ad pted f r climbing trees. M nk s seiz thin branches ropes, with th thumb sid and th fingers and palm n th th in th sam mann as w do Th y can th also lift rath r larg objects, cl as the eck of bottle to th m ths. Baboons turn t es, and scratch p roots with their hands. Th seize n ts, sects, oth small objects with th th mb in ppo t n t th fin rs, and n d bt th y thu tract ggs and u g from th n ts of b rds. Am ri can m nkey be t th wild ranges n th branches u til th rind cracked and th n tear t ff with th fingers f th two hands. In ld t t th break pe hard fru ts with

parasit s. Th roll d wn t s, o throw tl m t th mies rth l ss, th y are l m these arı u acti ns, and as I h m self see are q t unable t throw a t n th precis

It seems t m far from tru that because object are grasped lumsil by m k s, m ch less pec alised rgan f preh nsi w ld ha served th m[7] eq all w ll w th thei prese t hand On th co trary I see no reaso t d bt that m re perfectly co tructed hand would l bee an ad anta t th m pro ded th t tl w re t thus rend red less fitted f l mb g trees. It may suspect th t hand as perfect as tl t of man ould ha bee disad antageous f umb- ing f th most arboreal m nk n tl orld, nam l At les Am rica, Colobus in Africa, and Hylobate Asia, are th

th mbless, o their toes partially coh re so that th ir limbs are co verted i to mere gra p- ing hooks.[7]

As soon as some ancient member n the gre t series of the primates came to be less arboreal wing to change n its mann f procuring ubsi t nce o to som cl ang th surround cond t o s, ts hal t al man f progres n would ha e been mod fied and th t would h been rend red more tri tly quadrupedal or b pedal Baboons fre- qu t hilly and rocky di tri ts, a d nly from necessity climb l gh trees[7] and they h acquired almost th gait of d g Man alone has becom a b ped an I w can, I think, partl see h w h has com t assum hi erect at titud whicl f rms ne f his most con p us M n co ll t h ve ttained h

instrum ts, and b its correspondence w th th tellect gi es him uni rsal dominı n. B t th hand nd arm could hardl h v be- com perfect gh to h e manufactured w pons, o to ha e hurled tones and pears w th true aim, as l g as tl y were habit ally used f locomoti n and f supporti g th wh l weight of the bod as bef re re- marked, so l g as th y w re specially fitted for limbing trees. S ch ro gh tre tm nt w uld also b e bl ted th sense f to ch, on whi h th ir d li t se larg l d pends. From th se causes alo t w ld h v been an ad anta e t man to becom a b ped b t f r many ac ti ns it di pensable th t th arms and whol ppe part of th body h uld be free and h mu t f th nd tand firml n hi feet. To gain this gre t ad antag the feet h bee rend red flat and th gre t toe has been peculiarl modified th gh thi has n tailed th almost compl t loss f ts pow f preh nsi n. It accords with th principle f the divisi n of ph si l gical labo pre aili g

*Ow n, *Anatomy of Vertebrates*, ol. iii., p. 71
[7] Q *arterly Review* April, 1869 p. 59.

arboreal and traordi arily cti (Brehm, *Illus- trierte Thierleben*, B i., s. 50), b t wh ther better climber tha the pecies of the llied ge era, I d t know It deserves tice that the feet of th sloths, th most arboreal nimals the world, are w der- full hooklik

[7] Brehm, *Illustrierte Thierleben*, B i., s. 80
[7] The Hand, &c *Bridg ater Treatise* 1833, p. 38.

the one half which included all the individuals best adapted by their powers of movement for gaining subsistence or for defending themselves would on an average survive in greater numbers, and procreate more offspring than the other and less well endowed half

Man in the rudest state in which he now exists is the most dominant animal that has ever appeared on this earth He has spread more widely than any other highly organised form and all others have yielded before him He manifestly owes this immense superiority to his intellectual faculties to his social habits which lead him to aid and defend his fellows and to his corporeal structure The supreme importance of these characters has been proved by the final arbitrament of the battle for life Through his powers of intellect articulate language has been evolved and on this his wonderful advancement has mainly depended As Mr Chauncey Wright remarks A psychological analysis of the faculty of language shews that even the smallest proficiency in it might require more brain power than the greatest proficiency in any other direction [66] He has invented and is able to use various weapons tools traps &c with which he defends himself kills or catches prey and otherwise obtains food He has made rafts or canoes for fishing or crossing over to neighbouring fertile islands He has discovered the art of making fire by which hard and stringy roots can be rendered digestible and poisonous roots or herbs innocuous This discovery of fire probably the greatest ever made by man excepting language dates from before the dawn of history These several inventions, by which man in the rudest state has become so pre eminent are the direct results of the development of his powers of observation memory curiosity imagination and reason I cannot therefore understand how it is that Mr Wallace[67] maintains that natural selection could only have endowed the savage with a brain a little superior to that of an ape

Although the intellectual powers and social habits of man are of paramount importance to him we must not underrate the importance of his bodily structure to which subject the remainder of this chapter will be devoted the development of the intellectual and social or moral faculties being discussed in a later chapter

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self or in killing birds requires the most consummate perfection in the correlated action of the muscles of the hand arm and shoulder and further a fine sense of touch In throwing a stone or spear and in many other actions, a man must stand firmly on his feet and this again demands the perfect co-adaptation of numerous muscles To chip a flint into the rudest tool or to form a barbed spear or hook from a bone demands the use of a perfect hand for as a most capable judge Mr Schoolcraft [68] remarks the shaping fragments of stone into knives lances or arrow heads shews extraordinary ability and long practice This is to a great extent proved by the fact that primeval men practised a division of labour each man did not manufacture his own flint tools or rude pottery but certain individuals appear to have devoted their lives to such work no doubt receiving in exchange the produce of the chase Archæologists are convinced that an enormous interval of time elapsed before our ancestors thought of grinding chipped flints into smooth tools One can hardly doubt, that a man like animal who possessed a hand and arm sufficiently perfect to throw a stone with precision or to form a flint into a rude tool could with sufficient practice as far as mechanical skill alone is concerned make almost anything which a civilised man can make The structure of the hand in this respect may be compared with that of the

[66] Limits of Natural Selection North American

publish d The Essay o M has be n a y crit cised by Prof Clap rède on of th most dis- t nguished ool gists in Eu ope n art le p b- l hed the B bliothèq e U er lle J e 18 0 Th r mark quoted in my te t w ll urpris v ry o e wh has read M Wallace s cel b r ted pape n The Origin f Hum n Race Deduced fro th Theory of Natural Selectio ginally pul lisl ed in the A thr pological Rev w M y 1864 p. cl xx.

In th adult m le antl ropom rph pes, as Rutim y [11] and th h i ted it i th ff t th kull f the gre t d el p-me t f th j w m scl s th t c s t t d ff so gr tly many re pects f m th t f man, d has g n to th m l a truly right f l physi gn my Th f as th j w and teeth in man p g nito g ad ally b com r d d n th dult k ll ld l com to resembl m and m e tl t f xist g m A we h ll h e fte e a gr t ed tio of th canin teeth n the mal s w ld alm t ce ta nly ffect the t eth of the f m l th gl nh tan

A th an s me t l facult s g ad ally d l ped th m l the b a w ld almo t rta ly becom l ge No e, I p um d bts th t th larg p po t wh h th s f m b ai be to his body m pared t th sam p po t i th g ll g l ly nn ted w th hi high m t l po W m t w th l ly anal g fact th sect f n ants th

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sol t mass f m tt tl th w n d f lly d fied tr cts, m tal p s, d affect f ts t y t th e b al gangl t so l g as th q rt f m ll p h ad U d thus po t f ew th b ai f an ant f th m t m rv l l tom f m tt th w ld pe h p m so th th b f man.

Th b l f th t th t man m l se l t bet tl f th b ain and th d l pm t f th t llect al fac lt ppo ted by th compariso f tl kulls f sa ag d ci l sed aces, f anci t and

th m et th entury kulls from g a s in P ris we e larg r th i th se f om v lts of tl tw lftl ntury in th p p rti n of 1484 to 1426 and that th in ased iz as a e ta ed by m as em nts, was xclusi ly n th f t l part f tl skull—th seat f tl i t llect al faculties Pr cha d i persuaded th t the p esent inhab ta ts f Britain ha e much m e capaci brai cases than the

re pect t the l we anim ls M E Lart t [12] by comp ri g tl ran f t tiary and r cent mammals bel g g t th sam group l as come to the r mark ble co clus th t the b is gen ally larg r nd the convolut ns are m compl in the m r ec nt f rms On tl tl r l and I h shewn [13] th t tl e brains f d m ti abb t e consid bly red ed b lk n compar on w th those f th wild bb t r har and this m y b ttrib ted to th ha g been closely co fined duri g many g n ti ns, s th t tl y have rted the r i t llect, ti cts, sens and l t ry m m ts b t httl

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Ph losoph al T ctions 1869 p. 513

throughout the animal kingdom that as the hands became perfected for prehension the feet should have become perfected for support and locomotion With some savages however the foot has not altogether lost its prehensile power as shewn by their manner of climbing trees and of using them in other ways [7]

If it be an advantage to man to stand firmly on his feet and to have his hands and arms free of which from his pre eminent success in the battle of life there can be no doubt then I can see no reason why it should not have been advantageous to the progenitors of man to have become more and more erect or bipedal They would thus have been better *able to defend themselves with stones or clubs* to attack their prey or otherwise to obtain food The best built individuals would in the long run have succeeded best and have survived in larger numbers If the gorilla and a few allied forms had become extinct it might have been argued with great force and apparent truth that an animal could not have been gradually converted from a quadruped into a biped as all the individuals in an intermediate condition would have been miserably ill fitted for progression But we know (and this is well worthy of reflection) that the anthropomorphous apes are now actually in an intermediate condition and no one doubts that they are on the whole well adapted for their conditions of life Thus the gorilla runs with a sidelong shambling gait but more commonly progresses by resting on its bent hands The long armed apes occasionally use their arms like crutches swinging their bodies forward between them and some kinds of Hylobates, without having been taught can walk or run upright with tolerable quickness yet they move awkwardly and much less securely than man We see in short in existing monkeys a manner of progression intermediate between that of a quadruped and a biped but, as an unprejudiced judge [8] insists the anthropomorphous apes approach in structure more nearly to the bipedal than to the quadrupedal type

As the progenitors of man became more and more erect with their hands and arms more and more modified for prehension and other purposes with their feet and legs at the same time transformed for firm support and progression endless other changes of structure would have become necessary The pelvis would have to be broadened the spine pecu

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in man Various other structures which appear connected with man s erect position might here have been added It is very difficult to decide how far these correlated modifications are the result of natural selection and how far of the inherited effects of the increased use of certain parts or of the action of one part on another No doubt these means of change often co operate thus when certain muscles and the crests of bone to which they are attached become enlarged by habitual use this shews that certain actions are habitually performed and must be serviceable Hence the individuals which performed them best would tend to survive in greater numbers

The free use of the arms and hands partly the cause and partly the result of man s erect position appears to have led in an indirect manner to other modifications of structure The early male forefathers of man were as previously stated probably furnished with great canine teeth but as they gradually acquired the habit of using stones clubs or other weapons for fighting with their enemies or rivals they would use their jaws and teeth less and less In this case the jaws together with the teeth would become reduced in size as ... from innumerable ana... me... tion of ... teeth in male ruminants apparently in relation with the development of their horns and in horses in relation to their habit of fighting with their incisor teeth and hoofs

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In the ad lt mal antl pomorphous pes, as Rütim y [?] and th s, ha e nsisted it is the ffect th sk ll f tl gre t d elop- m t f th j w muscle that ca se it to d ffe so gre tly in m y espects f m that of man, and has gi en to th se animals truly right ful physi gnomy Th f as th j s and teeth n man prog nitors gradually becom reduced i size th ad lt k ll w ld h come to resemi l m and m re that f exist- m As w shall h afte see a great

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As th ari us m tal facult g adually d loped tl mselv th b ain ld alm t rtainly becom l g r N e I p ume d bts that tl la g p port wh h the ze f man b ai be r to his body com pared to tl e sam p port th g rilla ang, l scly o cted ith his high r m tal po W mect th losely anal facts tl sects f i ant th ce e-

d rs, ch as beetles [7] O tl tl e hand, n pposes that th intellect f y t ani

s l te mas f us matte thus tl w n d rfully di rsified nstincts, m tal po rs, and affecti ns f ants are notor n us, y t th ir ce b al gangli ar not so la g as th quarte of mall p n head And thus po t f i w th brain f an ant is f th m t marv l lous toms f matte th ld pe hap m so than tl b ai f man.

Th bel f that th re xi ts n man som lose relat betwee th ize f th b ain and th d lopm t f th intellect al faculti is pported by th compariso f th k lls f sa g and ci lised races f anc t and

Eur peans is 92.3 cul ic inches in Americans 87.5 in A at cs 87 1 and in Aust al ans ly 81 9 cul c in hes Irofesso B oca[10] fo d th t the ni teenth century k ll fr m gra s in Pari w e large than tl se f om ults f tl e t elftl ce t ry in tl pr port on f 1484 to 1426 and that the n ased size, as ascer tained by measu m nts was exclus ly n tl f tal part f the kull—the seat of tl i tellectual facult es Irichard is persuaded th t th p ese t inhal ta ts f Britain h m ch mo capaci us b ai case than the anci t nhal tants. N v rtl eless, it m t be adm tted that som k ll of ery higl an t q ty h as tl fam us ne of Neande th l, a w ll d l ped an l capacious [11] W th r pect to the l e an mals, M. E Lartet [12] by compari g th crania f tert ary nd cent

ar m compl n tl m e ecent f rms. On tl otl l and I l e h wn[13] th t the b ains f d m t ral l t ar consid rably ed ced b lk, n comparis w tl th se f the w ld ral b t har and th may b ttrib- uted to th ha i g been closel confi ed

Th gradually c eas g w ght f the b ain and kull in man must h e infl ced th d l pm t f tl s pport g p nal column, m pecially wh lst he was b om ing ect As tl s cha ge of po ti n was be g bro ght abo t, th internal p ss f th b ain w ll lso ha nfl ed th f rm f th skull f ma y facts h w l w asily th kull

Die G enzen der Thierwelt, eine Bet acht g zu D rwi Leh 1868 1

D ardin, A nale de Scienc Nat 3rd series, Zoolog t.m. 1850 p 203 See lso M Lowne Anatomy nd Phy f the Musca m t sca, 1870 p 14 My son, M F D rwi n, dissected f me the cerebral g lia of the Formic rufa.

Philosophical T nsactions 1869 p. 513

[10] L oca thus plains th therwise inexplical le fact, that the mea capac ty of the kull f the ncie t troglodytes of Lozère is greater than that of modern F nchmen.

[12] C mptes-rendus d Scienc & June 1 1868

[13] The V riation f A mals d Plants nder Do- mestication l. i, pp 124-129

throughout the animal kingdom, that as the hands became perfected for prehension, the feet should have become perfected for support and locomotion. With some savages, however, the foot has not altogether lost its prehensile power, as shewn by their manner of climbing trees, and of using them in other ways.[6]

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As the progenitors of man became more and more erect, with their hands and arms more and more modified for prehension and other purposes, with their feet and legs at the same time transformed for firm support and progression, endless other changes of structure would have become necessary. The pelvis would have to be broadened, the spine peculiarly curved, and the head fixed in an altered position, all which changes have been attained by man. Prof. Schaaffhausen[8] maintains that the powerful mastoid processes of the human skull are the result of his erect position; and these processes are absent in the orang, chimpanzee, &c., and are smaller in the gorilla than in man. Various other structures, which appear connected with man's erect position, might here have been added. It is very difficult to decide how far these correlated modifications are the result of natural selection, and how far of the inherited effects of the increased use of certain parts, or of the action of one part on another. No doubt these means of change often co-operate: thus when certain muscles, and the crests of bone to which they are attached, become enlarged by habitual use, this shews that certain actions are habitually performed and must be serviceable. Hence the individuals which performed them best, would tend to survive in greater numbers.

The free use of the arms and hands, partly the cause and partly the result of man's erect position, appears to have led in an indirect manner to other modifications of structure. The early male forefathers of man were, as previously stated, probably furnished with great canine teeth; but as they gradually acquired the habit of using stones, clubs, or other weapons, for fighting with their enemies or rivals, they would use their jaws and teeth less and less. In this case, the jaws, together with the teeth, would become reduced in size, as we may feel almost sure from innumerable analogous cases. In a future chapter we shall meet with a closely parallel case, in the reduction or complete disappearance of the canine teeth in male ruminants, apparently in relation with the development of their horns; and in horses, in relation to their habit of fighting with their incisor teeth and hoofs.

given good cases of the use of the foot as a prehensile organ by man; and has also written on the manner of progression of the higher apes, to which I allude in the following paragraph: see also Owen ('Anatomy of Vertebrates,' vol. iii. p. 71) on this latter subject.

[7] [illegible] of Broca, 'La Constitution des Vertèbres caudales,' 'La Revue d'Anthropologie,' 18[illegible], p. [illegible]6 (separate copy).

[8] 'On the Primitive Form of the Skull,' translated in 'Anthropological Review,' Oct. 1868, p. 428. Owen ('Anatomy of Vertebrates,' vol. ii. 1866, p. 551) on the mastoid processes in the higher apes.

became naked through the action of the sun. Mr Belt believes[*] that within the tropics it is an advantage to man to be destitute of hair as he is thus enabled to free himself of the multitude of ticks (acari) and other parasites, with which *he is often infested*, and which sometimes cause ulceration. But whether this evil is of sufficient magnitude to have led to the denudation of his body through natural selection, may be doubted, since none of the many quadrupeds inhabiting the tropics have, as far as I know acquired any specialised means of relief. The view which seems to me the most probable is that man, or rather primarily woman, became divested of hair for ornamental purposes, as we shall see under Sexual Selection and, according to this belief it is not surprising that man should differ so greatly in hairiness from all other primates, for characters, gained through sexual selection, often differ to an extraordinary degree in closely related forms.

According to a popular impression, the absence of a tail is eminently distinctive of man but as those apes which come nearest to him are destitute of this organ, its disappearance does not relate exclusively to man. The tail often differs remarkably in length within the same genus thus in some species of Macacus it is longer than the whole body and is formed of twenty-four vertebræ in others it consists of a scarcely visible stump, containing only three or four vertebræ. In some kinds of baboons there are twenty-five whilst in the mandrill there are ten very small stunted caudal vertebræ or according to Cuvier[*] sometimes only five. The tail, whether it be long or short, almost always tapers towards the end and this, I presume results from the atrophy of the terminal muscles, together with their arteries and nerves, through disuse leading to the atrophy of the terminal bones. But no explanation can at present by given of the great diversity which often occurs in its length. Here however we are more specially concerned with the complete external disappearance of the tail. Professor Broca has recently shewn[*] that the tail in all quadrupeds consists of two portions, generally separated abruptly from each other the basal portion consists of vertebræ, more or less perfectly channelled and furnished with apophyses like ordinary vertebræ whereas those of the terminal portion are not channelled, are almost smooth, and scarcely resemble true vertebræ. A tail, though not externally visible, *is really present* in man and the anthropomorphous apes, and *is constructed* on exactly the same pattern in both. In the terminal portion the vertebræ constituting the *os coccyx* are quite rudimentary being much reduced in size and number In the basal portion, the vertebræ are likewise few are united firmly together and are arrested in development but they have been rendered much broader and flatter than the corresponding vertebræ in the tails of other animals they constitute what Broca calls the accessory sacral vertebræ. These are of functional importance by supporting certain internal parts and in other ways and their modification is directly connected with the erect or semi-erect attitude of man and the anthropomorphous apes. This conclusion is the more trustworthy *as Broca formerly held a different* view which he has now abandoned. The modification, therefore, of the basal caudal vertebræ in man and the higher apes may have been effected, directly or indirectly through natural selection.

But what are we to say about the rudimentary and variable vertebræ of the terminal portion of the tail, forming the os coccyx A notion which has often been, and will no doubt again be ridiculed, namely that friction has had something to do with the disappearance of the external portion of the tail, is not so ridiculous as it at first appears. Dr Anderson[*] states that the extremely short tail of *Macacus brunneus* is formed of eleven vertebræ including the imbedded basal ones. The extremity is tendinous and contains no vertebræ this is succeeded by five rudimentary ones, so minute that together they are only one line and a half in length, and these are permanently bent to one side in the shape of a hook. The free part of the tail, only a little above an inch in length, includes only four more small vertebræ. This short tail is carried erect but about a quarter of its total length is doubled on to itself to the left and this terminal part, which includes the

[*] *The Naturalist in Nicaragua*, 1874, p. 209 As some confirmation of Mr Belt's view I may quote the following passage from Sir W Denison (*Varieties of Vice-Regal Life* vol i, 1870, p. 440) It is said to be a practice with the Australians, when the vermin get troublesome to singe themselves.

[*] Mr St. George Mivart, *Proc Zoolog Soc* 1865, pp. 56 583. Dr J E. Gray *Cat. Brit. Mus* Skeletons. Owen, *Anatomy of Vertebrates*, vol. ii, p. 51 Isidore Geoffroy *Hist. Nat. Gen.*, tom. ii, p. 244.

[*] *Revue d'Anthropologie* 1872 La Constitution des vertèbres caudales.

[*] *Proceedings Zoological Society* 1872, p. 210.

is thus effected Ethnologists believe that it is modified by the kind of cradle in which infants sleep Habitual spasms of the muscles and a cicatrix from a severe burn have permanently modified the facial bones In young persons whose heads have become fixed either side ways or backwards owing to disease one of the two eyes has changed its position and the shape of the skull has been altered apparently by the pressure of the brain in a new direc tion [84] I have shewn that with long eared rab bits even so trifling a cause as the lopping for ward of one ear drags forward almost every bone of the skull on that side so that the bones on the opposite side no longer strictly correspond Lastly if any animal were to in crease or diminish much in general size with out any change in its mental powers or if the mental powers were to be much increased or diminished without any great change in the size of the body the shape of the skull would almost certainly be altered I infer this from my observations on domestic rabbits some kinds of which have become very much larger than the wild animal whilst others have re tained nearly the same size but in both cases the brain has been much reduced relatively to the size of the body Now I was at first much surprised on finding that in all these rabbits the skull had become elongated or dolichocephalic for instance of two skulls of nearly equal breadth the one from a wild rabbit and the other from a large domestic kind the former was 3 15 and the latter 4 3 inches in length [85] One of the most marked distinctions in different races of men is that the skull in some is elongated and in others rounded and here the explanation suggested by the case of the rabbits may hold good for Welcker finds that short men incline more to brachycephaly and tall men to dolicho- cephaly [86] and tall men may be compared with the larger and longer bodied rabbits all of which have elongated skulls, or are dolichocephalic.

From these several facts we can understand to a certain extent, the means by which the great size and more or less rounded form of the skull have been acquired by man and these are characters eminently distinctive of him in comparison with the lower animals.

Another most con picuous difference be- tween man and the lower animals is the naked ness of his skin Whales and porpoises (Ce- tacea) dugongs (Sirenia) and the hippopotamus are naked and this may be advantageous to them for gliding through the water nor would it be injurious to them from the loss of warmth as the pecies which inhabit the colder regions, are protected by a thick layer of blubber serv ing the same purpose as the fur of seals and otters Elephants and rhinocero es are almo t hairless and as certain extinct pecies, which formerly lived under an arctic climate were covered with long wool or hair it would almo t appear as if the exi ting pecies of both genera had lost their hairy covering from expo ure to heat. This appears the more probable as the elephants in India which live on elevated and cool districts are more hairy[87] than those on the lowlands May we then infer that man be came divested of hair from having aboriginally inhabited some tropical land? That the hair is chiefly retained in the male sex on the chest and face and in both sexes at the junction of all four limbs with the trunk favours this in ference—on the assumption that the hair was lost before man became erect for the parts which now retain most hair would then have been most protected from the heat of the sun The crown of the head however offers a cu rious exception for at all times it must have been one of the mo t exposed parts, yet it is thickly clothed with hair The fact, however that the other members of the order of pri mates to which man belongs, although in habiting various hot regions are well clothed with hair generally thickest on the upper sur face [88] is opposed to the supposition that man

Review Oct. 1868, p 419

[87] O en, *Anatomy of V t b ate* vol iii p 619
[88] Is d re Geoffroy St H la re remarks (*Histoi e N t G l* t m 18 9 p 215-217) the
m f t m 1854 p 28) h er st tes th t th g rilla th hair is th er th b ck, wh re t is partly rubbed off th n th l er urface.

merely consid sufficiently th existence of structures, which, as far as w can t present judge are either beneficial no injurious and this I believe to be one of the greatest sights as yet detected in my work. I may be permitted to sa as some excuse that I had tw distinct objects in w firstl to sh w that species had not been separately created, and secondly that natural selection had been the chief agent of change though largely aided b the inherited effects of habit, and slightly b the direct action of the surrounding conditions. I was not, however able to annul th influence of my former belief th n almost universal, that each species had been purposely created and this led t m tacit assumption that every detail of structure exceptin rudiments, was of som special, though unrecognised, service An one with this assumption in his mind would naturall extend too far th action of natural selection, either during past or present times. Some f those who admit th principle of evolution, but reject natural selection, seem t forget, when criticising m book, that I had th above two objects in w hence if I ha erred in giving t natural selection great power which I am very far from admitting, or in having exaggerated its power which is in itself probable I ha t least, as I hope done good service in aiding t overthrow th dogma of separate creations.

It is, as I can now see probable that all organic beings, including man, possess peculiarities of structure, which either are now no were formerl of an service to th m, and which, therefore are of no physiological importance W know not what produces th numberless slight differences between th individuals of each species, for reversion only carries the problem f w steps backwards, b t each peculiarity must ha had its efficient cause If these causes, hat er th ma be w re to act more uniforml and er tically during lengthened period and against this no reason can be assigned the result would probabl be not mere slight individual difference, but w ll-marked and constant modification, though one of no physiological importance Changed structures, which are in no w beneficial, cannot be kept uniform through natural selection, though the injurious will be eliminated. Uniformity of character would however naturally follow from the assumed uniformity of the exciting causes, and likewise from the free intercrossing of man individuals. During successive periods, the

same organism might in this manner acquire successive modifications, which would be transmitted in a nearly uniform state as long as the exciting causes remained the same and there was free intercrossing. With respect to the exciting causes we can only say as when speaking of so-called spontaneous variations, that they relate much more closely to the constitution of the varying organism, than to the nature of the conditions to which it has been subjected.

Conclusion.—In this chapter we have seen that as man at the present day is liable like every other animal, to *multiform* individual differences or slight variations, so no doubt were the early progenitors of man the variations being formerly induced by the same general causes, and governed by the same general and complex laws as at present. As all animals tend to multiply beyond their means of subsistence, so it must have been with the progenitors of man and this would inevitably lead to a struggle for existence and to natural selection. The latter process would be greatly aided by the inherited effects of the increased use of parts, and these two processes would incessantly react on each other It appears, also, as we shall hereafter see that various unimportant characters have been acquired by man through sexual selection. An unexplained residuum of change must be left to the assumed uniform action of those unknown agencies, which occasionally induce strongly marked and abrupt deviations of structure in our domestic productions.

Judging from the habits of savages and of the greater number of the Quadrumana, primeval men, and even their ape-like progenitors, probably lived in society With strictly social animals, natural selection sometimes acts on the individual, through the preservation of variations which are beneficial to the community A community which includes a large number of well-endowed individuals increases in number and is victorious over other less favoured ones even although each separate member gains no advantage over the others of the same community Associated insects have thus acquired many remarkable structures, which are of little or no service to the individual, such as the pollen-collecting apparatus, or the sting of the worker bee or the great jaws of soldier-ants. With the higher social animals, I am not aware that any structure has been modified solely for the good of

hook like portion serves to fill up the inter space between the upper divergent portion of the callosities so that the animal sits on it and thus renders it rough and callous Dr Anderson thus sums up his observations These facts seem to me to have only one explanation this tail from its short size is in the monkey s way when it sits down and frequently becomes placed under the animal while it is in this attitude and from the circumstance that it does not extend beyond the extremity of the i chial tuberositie it seems as if the tail originally had been bent round by the will of the animal into the interspace between the callosities to escape being pressed between them and the ground and that in time the curvature became permanent fitting in of itself when the organ happens to be sat upon Under these circumstances it is not surprising that the surface of the tail should have been roughened and rendered callous and Dr Murie[93] who carefully observed this species in the Zoological Gardens as well as three other closely allied forms with slightly longer tails says that when the animal sits down the tail is necessarily thrust to one side of the buttocks and whether long or short its root is consequently liable to be rubbed or chafed As we now have evidence that mutilations occasionally produce an inherited effect[94] it is not very improbable that in short tailed monkeys the projecting part of the tail being functionally useless should after many generations have become rudimentary and distorted from being continually rubbed and chafed We see the projecting part in this condition in the *Macacus brunneus* and absolutely aborted in the *M ecaudatus* and in several of the higher apes Finally then as far as we can judge the tail has disappeared in man and the anthropomorphous apes owing to the terminal

as to become suitable to the erect or semi erect position

I have now endeavoured to shew that some of the most distinctive characters of man have in all probability been acquired either directly or more commonly indirectly through natural selection We should bear in mind that modifications in structure or constitution which do not serve to adapt an organism to its habits of life to the food which it consumes or passively to the surrounding conditions, cannot have been thus acquired We must not however be too confident in deciding what modifications are of service to each being we should remember how little we know about the u e of many parts or what changes in the blood or tissues may serve to fit an organism for a new climate or new kinds of food Nor must we forget the principle of correlation by which as Isidore Geoffroy has shewn in the case of man many strange deviations of structure are tied together Independently of correlation a change in one part often leads through the increased or decreased use of other parts to other changes of a quite unexpected nature It is also well to reflect on such facts as the wonderful growth of galls on plants caused by the poison of an insect and on the remarkable changes of colour in the plumage of parrots when fed on certain fishes or inoculated with the poison of toads[95] for we can thus ee that the fluids of the system if altered for some pecial purpose might induce other changes We should e pecially bear in mind that modifications acquired and continually used during past ages for some useful purpose would probably become firmly fixed and might be long inherited

Thus a large yet undefined extension may *safely be given to the direct and indirect re*sults of natural selection but I now admit after reading the essay by Nageli on plants and the remarks by various authors with respect to animals more e pecially tho e recently made by Professor Broca, that in the earlier editions of my *Origin f Species* I perhaps attributed too much to the action of natural selection or the survival of the fitte t I have alte d the fifth edition of th *Origin* so as to confine my remarks to adapti e har ges of structure l ut I am con ine d from the light gained luring ven the la t fe years, that very many structures which no v ap pear to us useles ill l ereafter be pro e l to be useful and will therefore come withm the range of natural selection Neverthele s, I di l not for

e tly i h t d ff t f t ot b t g tt u barbs of th ir own t il f th See ls th ge e al s bject *Variat f A m ls d Pla ts under Domesticat o i*, ol i pp 22 24

[95] *The V ri t o i f A mals d P l ts der Domest cat o* v l. ii pp 280 282

CHAPTER III

COMPARISON OF THE MENTAL POWERS OF MAN AND THE LOWER ANIMALS

We have seen th last two chapters that man bears in his bodil tructure cl ar traces of his desce t from som low f rm b t t may be r ed that, as man diff rs so greatly in his mental pow from all th animals, th re must be som erro in this co clusi n. N doubt th diff rence in this respect is n rm us, e en if w compare th mind f on f the l west sa ages, wh has no w rds t xpress any num be high than f ur and wh uses hardly any abstract t rms f comm objects f the affections, with that of the most highly organ ised pe. Th diff rence w uld d bt, till remain imm nse n if o of th hi h pes had bee impro ed r ci ilised as m ch as a dog has been in comparison with its parent form, th w lf r jackal. Th F egians rank amo gst the lowest barbarians but I was continually truck with urprise h w closely th three nati es n board H. M. S. B gle who had li ed som years in England, and could talk little English, resembled us n di position and in most of our mental faculties. If n

My object n this chapt r is to shew th t th re is no f dam ntal diff rence between man and th hi he mammals n th ir m ntal faculties. Each di isi n f th subject m ght ha e been e tended into a separate essay b t must h re be tre ted bri fl As no classification f th m ntal powers has been uni rsally accepted, I shall arrang my remarks the rd most con enient fo my p rpose and will select those facts which ha e truck me most, with the h pe th t th y may prod ce som ffect on th read r

W th respect t animals ry l w in the scale I ll n som addit nal facts unde Sexual

als of the sam species is an important point f r us, and som f w illustrat ns will here be gi n. B t t w uld be perflu us to nt r into many d tails n this head, fo I have f und on fre q nt quiry th t it is th unanim us pini n of all those who ha l g att nded to animals of many kinds, in l di birds, th t th ind d als diff greatly in ry m ntal harac teristic. In what mann th m ntal pow rs w re first de l ped n th l west organisms,

ence of this kind. W must also admit th t th re is much w d interval n m al po r betwee f th lowest fishes, as lamprey or lancel t, and of th hi h r pes, than between an pe and man y t this int rval is filled p by numbe less gradati ns.

N is the difference slight in m ral disposition between barbarian, such as th man described by th old navigator Byron, who dashed his child on th rocks f droppi g basket f sea-urchins, and H ward r Clark so and in int llect, between sa ag who uses hardly an abstract terms, and N wt or Shakespeare Diff rences of this kind between th high t m of th high t races and the lowest savages, are connected by th fi est gradations. Th refore t is possibl that they might pass and be d loped int each th

See the evidence on those poi ts, as given by Lubbock, Prehistoric Times p. 354, &c.

As man possesses th same senses as the l w animals, his fundamental intuiti ns must be th sam Man has also som f w inst n ts in comm n, as that f self preservati n, sexual lo the lo f th m th f h n w born off prin, the d si possessed b th latt to suck, and so forth. B t man, pe haps, has somewhat f wer instincts than those possessed by the animals which com next to him n the series. Th ran in the Eastern lands, and th chimpanzee in Africa, build platf rms on which they sleep and, as both species f llow th sam habit, t might be argued that this was d to instinct, b t w cann t feel ure that t is not th result of both animals having similar wants, and possessing similar pow rs f reason ing. These pes, as w m y assume, v d th many poison us fruits of th trop cs, and man has no uch kn wledge b t as ur d mestic animals, wh n taken to f re gn lands, and

the community though some are of secondary service to it For instance the horns of ruminants and the great canine teeth of baboons appear to have been acquired by the males as weapons for sexual strife but they are used in defence of the herd or troop In regard to certain mental powers the case as we shall see in the fifth chapter is wholly different for these faculties have been chiefly or even exclusively gained for the benefit of the community and the individuals thereof have at the same time gained an advantage indirectly

It has often been objected to such views as the foregoing that man is one of the most helpless and defenceless creatures in the world and that during his early and less well developed condition he would have been still more helpless The Duke of Argyll for instance insists[96] that the human frame has diverged from the structure of brutes in the direction of greater physical helplessness and weakness That is to say it is a divergence *which of all* others it is most impossible to ascribe to mere natural selection He adduces the naked and unprotected state of the body the absence of great teeth or claws for defence the small strength and speed of man and his slight power of discovering food or of avoiding danger by smell To these deficiencies there might be *added one still more serious namely that he* cannot climb quickly and so escape from enemies The loss of hair would not have been a great injury to the inhabitants of a warm country For we know *that the unclothed* Fuegians can exist under a wretched climate When we compare the defenceless state of man with that of apes we must remember that the great canine teeth with which the latter are provided are possessed in their full develop-

to survive

In regard to bodily size or strength we do not know whether man is descended from some small species like the chimpanzee or from one as powerful as the gorilla and therefore we cannot say whether man has become larger and stronger or smaller and weaker than his ancestors *We should however bear in mind that* an animal possessing great size strength and ferocity and which like the gorilla, could defend itself from all enemies would not perhaps have become social and this would most effectually have checked the acquirement of the higher mental qualities such as sympathy and the love of his fellows Hence it might have *been an immense advantage to man to have* sprung from some comparatively weak creature

The small strength and speed of man his want of natural weapons &c are more than counterbalanced firstly by his intellectual powers through which he has formed for himself weapons tools &c though still remaining in a barbarous state and secondly by his social qualities which lead him to give and receive aid from his fellow men No country in the world abounds in a greater degree with dangerous beasts than southern Africa no country presents more fearful physical hardships than the arctic regions yet one of the puniest of races that of the bushmen maintains itself in southern Africa as do the dwarfed Esquimaux in the arctic regions The ancestors of man were no doubt inferior in *intellect and probably in social disposition* to the lowest existing savages but it is quite con

such as that of climbing trees &c But these ancestors would not have been exposed to any special danger even if far more helpless and defenceless than any existing savages, had

natural selection arising from the competition of tribe with tribe in some such large area as one *of these together with th inherited effects* of habit, would under favourable conditions have sufficed to raise man to his present high position in the organic scale.

[96] *Primeval Man*, 1869 p 66

ce
perf rmed by the l r animals, nam is tn t man ann t, n hi fir t trial mak f m tance ton h tch t r canoe th gh h po f imitati n. H has to l arn h w k
ce h r th oth l d can

h ld and p n ced
T return t mmed te bject th l animals, l k man m nifestly feel pl as ure and pain, h pp n ss nd misery H pp es bett xhib ted th b y ung

scribed b th t ll t bserv P H b wh w ants chas g and pret d g to b te each th lik so man p pp s.
Th fact th t th l w anim ls are cited by tl sam m ti ns as rsel so w ll established, that t will t b n cessary to w ary th read by many d ta l T rro acts m th sam mann th m as using th muscl to tr mbl th heart t palp tat th plunct rs to b laxed and th l ai t stand end Susp n, th ff p m ff ar em tly haracteri t f m t wild animals. It s, I think, mposs bl to read th account

taml nh rited E ry kn l w l bl animals are to f m g and h w plai l th l w t Man and p babl tru anec d t h bee p bl hed th l g-d l yed nd artful re g f ani nimals. Th accu te Rengg and B hm tat that th Am ri and African m nk y whi h th y

kept tam cert nly r v ged tl emselve S r Andr w Smith a zool g t wh se scrup l us acc acy was kn n t m y p rsons, told me th f ll w g t y f wh ch h was l mself an y w tn ss t the C pe f Good H pe an ffice had ft n pla ed a cert un b boo and th nimal se h m pp ach ng e S d y f r par d po ed wate nto h le nd hast l mad some tl k m d wl ch h skil fully dasl ed o th officer as h passed by to the musement f many by tand r F r l ng aft rward tl b boo r j ced and triumphed wh h saw l s ict m
Th l f ad g f h mast i n t n us as an ld writ q tly s ys, A d g is the only thi g n thi earth that l v y u m re

ss tu p
crease f kn ledge, r unl ss l l ad a h art f t u t h f lt rem rse t th

m th tw cases W see m t al affect n hib ted th m t trifl g d ta l th R g bse ed Am ri an m k (a Cebu.) ca fully dri ing w y th fl wl h pl gued l r nfant and D cel saw Hylo bates washi th fac f h y ung n a t m. So tense th gri f f f m l m n k y f th l ss f th y g th t t bly ca sed th d th f certain ki d k pt u d confin m t by B hm N Afri a. Orphan m nk y w re alw ys ad pted d arefully guarded b th th m nk ys, both mal and f males. O f m l b boon h d so capaci a h art tl t h t nly ad pted y un m nk y f the pec s, b t tol y g d gs and ts, whicl h co t n lly carried abo t. H ki dn ss ho d d n t g so far as to hare h food w t l h ad pted ff pri g, t which Brehm was rprised as his m nk l y d ded ry tl g q t fai ly w tl thei wn y g s. An ad pted kitt sc t hed thi affect nate baboon who

1 All the f ll g t t m ts, gi tl th y f these t natural ts, re take from Re g *Nat rg sch. der gether von I* y 1830 ss. 41-57 and from Brehm *Thierlebe* B i, ss. 10-87

when first turned out in the spring often eat poisonous herbs which they afterwards avoid we cannot feel sure that the apes do not learn from their own experience or from that of their parents what fruits to select It is however certain as we shall presently see that apes have an instinctive dread of serpents and probably of other dangerous animals

The fewness and the comparative simplicity of the instincts in the higher animals are re markable in contrast with those of the lower animals Cuvier maintained that instinct and intelligence stand in an inverse ratio to each other and some have thought that the intel lectual faculties of the higher animals have been gradually developed from their instincts But Pouchet in an interesting essay has shewn that no such inverse ratio really exists Those insects which possess the most wonderful in stincts are certainly the most intelligent In the vertebrate series the least intelligent mem bers namely fishes and amphibians do not possess complex instincts and amongst mam mals the animal most remarkable for its in stincts namely the beaver is highly intelligent as will be admitted by every on [illegible]

[illegible] to Mr Herbert Spencer [4] have been developed through the multiplication and co-ordination of reflex actions and although many of the simpler instincts graduate into reflex ac tions and can hardly be distinguished from them as in the case of young animals sucking yet the more complex instincts seem to have originated independently of intelligence I am however very far from wishing to deny that instinctive actions may lose their fixed and un taught character and be replaced by others performed by the aid of the free will On the other hand some intelligent actions after being performed during several generations become converted into instincts and are inherited as when birds on oceanic islands learn to avoid man These actions may then be said to be de graded in character for they are no longer performed through reason or from experience But the greater number of the more complex instincts appear to have been gained in a wholly different manner through the natural selection of variations of simpler instinctive ac tions Such variations appear to arise from the same unknown causes acting on the cerebral organisation which induce slight variations or individual differences in other parts of the body and these variations owing to our igno rance are often said to arise spontaneously We can I think come to no other conclusion with respect to the origin of the more complex in stincts when we reflect on the marvellous in stincts of sterile worker ants and bees which leave no offspring to inherit the effects of ex perience and of modified habits

Although as we learn from the above men tioned insects and the beaver a high degree of intelligence is certainly compatible with com plex instinct [illegible]

[illegible] tion yet it is not improbable that there is a certain amount of interference be tween the development of free intelligence and of instinct,—which latter implies some in herited modification of the brain Little is known about the functions of the brain but we can perceive that as the intellectual powers become highly developed the various parts of the brain must be connected by very intricate channels of the freest intercommunication and as a consequence each s[illegible] t would [illegible]swer to [illegible] a def [illegible] —man

[illegible] There seems even to exist some relation between a low degree of intelligence and a strong tendency to the formation of fixed though not inherited habits for [illegible]

[illegible] this is encouraged

I have thought this digression worth giving because we may easily underrate the mental powers of the higher animals, and especially of man when we compare their actions founded on the memory of past events on foresight, reason and imagination with exactly similar actions instinctively performed by the lower animals in this latter case the capacity of per forming such actions has been gained step by step through the variability of the mental organs and natural selection without any con scious intelligence on the part of the animal during each successive generation. No doubt as Mr Wallace has argued [5] much of the intel

[illegible] L Instinct [illegible] insect Revue des Deux Mondes Feb 18[illegible]0 p 690
The American B[illegible] and His W[illegible] 1868
The Principles of Psychology 2nd ed 18[illegible]0 pp 418–443

[5] Contributions to the Theory of Natural Selection 18[illegible]0 p 212

snake in p per b g, w th th mo th loosely losed f th larg comp rtm ts. On of th m nk y mmed tely pproa hed u ti usly pe ed th bag a little, peeped n, and instantly dashed w y Th n I tnessed what Brehm has described, fo m nkey afte m n k y with head raised h gh and turned n sid could not esist taki g a m me tary peep into the pright b g, at th dreadf l bject ly g qui tly t the bott m It wo ld almo t ppear as if m nk s had some ti n f o- l gical affinit s, f tl se k pt by Brehm xl b ted t ang th ugh ini tak n, instin ti dread f innoce t lizards and f gs. An rang, lso has been kn wn to b m ch alarmed t th first ght f a t rtl u

Th principl f *Imit tion* tro g in man, and especially as I h myself bserved with sa ages. In certain m b d tat f th b ain this t den y is gg rated to an t aordi nary d gree som h mipl g c p tient and thers, t th comm nceem t f inflammat ry soft ni g f th brain, unco isci sly im tate ry rd which tt red, wh tl r n tl n f gn langu g and ery g ture acti wh ch is perf med n th m D sor[11] has remarked th t animal l n tarily imitate an act n pe f rmed by man, t l in th asce d g scale w come to m n k ys, hich ar w ll kn n to be d c l us mock s. Animals, h som tim m tat each th act ns th t pec es f l es, hich had bee reared by d gs, l arned

an l p rrots re t m tato f any s l wh l th ft l ar D d la M ll g an acco t f a d re d by a cat wl l t to m t t tl ll kn wn ac t f cat l ki g l p s, d th wash h rs a d face this was lso w t essed b th cel b ted nat l t A d I l re ed se l co fi m t y acco t in e f these d g l ad t bee kled b cat, b t had bee bro ght p th t th tl k ttens, and had thus i ured th abo

W C L. Martin, *Nat al H story of M mmalia*, 1 41 p 405

1 B man O *Aphas a*, 18 p 110

Q ted by Vogt, *Mémoi le M crocéphale* 186 p. 168.

Th Variatio of A mals nd Pla ts nder Do me ution, vol 1., p. 2

Annale de Scienc Nat., (1 t series), tom, xxii., p. 397

hab t, wl ch h v r afterward pr ctised dur ing hi f t tee y ars Dure u de l Mall pl y w f rep assure he paws into j b mo th f r h r head A kitte f th cat soon learned th same tr ck, and practised t e er aft rwards, when r there was an ppo t ty

m re pecial tend nci s, m y be said to ed cat th m. We see thi wh n cat bri gs a li mouse to l kittens and Dure u d la Malle has gi n a curi acco t (in the p pe above quoted) of his observations n hawks which ta ght their y ng d terity as w ll as judgm nt of di tances, by first d pping through th air d ad mice and parrows, which th young ge erally failed t cat h and tl en bri gi g th m li birds and l tt g th m loose.

Hardly any faculty m re important f th tellect al progress f man than *Attention* Animals cl arl manifest this powe as wh n a cat w tcl es by a hol and prepares t pri g n t prey Wild animals sometim becom so bso bed wh n th s e g ged th t th y may be eas ly pproached M Bartlett has gi n m a rious proof h w ari bl thi faculty is i m nk ys. A man who t ains m n key to act pl s, used t purchase common kinds from th Zoolo cal Soc ty t th price f fi pounds f ach b t l e ff red to gi d bl tl price, f l m ght keep three r f u f th m f f w d s, rd t select n Wh asked h w h co ld poss bly learn so soon, wh th parti la m nk y w ul l turn

k y its att t was eas ly d tracted as by a fly th wall tl trifl g l ject the case was h peless. If h tr ed by p hm t to mak an in tte ti e m nk y act, t tur ed lky On tl th hand a m nk y which caref lly tt ded to him co ld alw y be trai ed

It s lmost perfl s t tate th t animals ha e cell t *Mem ries* f perso s and places A baboo t tl C pe f Good H pe, as I h bee f rmed by S A d w Smith recog nised l m w th j y aft an bse ce f nine m ths. I had a d who was sa ag and a erse

certainly had a fine intellect for she was much astonished at being scratched and immediately examined the kitten s feet and without more ado bit off the claws [11] In the Zoological Gardens I heard from the keeper that an old baboon (*C chacma*) had adopted a Rhesus monkey but when a young drill and mandrill were placed in the cage she eemed to perceive that the e monkeys though distinct species were her nearer relatives for she at once rejected the Rhesus and adopted both of the young drill and mandrill whenever it could do so with safety this conduct exciting great indignation in the old baboon Monkeys will also according to Brehm defend their master when attacked by any one as well as dogs to whom they are attached from the attacks of other dogs But we here trench on the subjects of sympathy and fidelity to which I shall recur Some of Brehm s monkeys took much delight in teasing a certain old dog whom they disliked as well as other animals in various ingenious ways

Most of the more complex emotions are common to the higher animals and ourselves Every one has seen how jealous a dog is of his master s affection if lavished on any other creature and I have observed the same fact with monkeys This shews that animals not only love but have desire to be loved Animals manifestly feel emulation They love approbation or praise and a dog carrying a basket for his master exhibits in a high degree self complacency or pride There can I think be no doubt that a dog feels shame as distinct from fear and something very like modesty when begging too often for food A great dog scorns the snarling of a little dog and this may be called magnanimity Several observers have stated that monkeys certainly dislike being laughed at and they sometimes invent imaginary offences In the Zoological Gardens I saw a baboon who always got into a furious rage when his keeper took out a letter or book and read it aloud to him and his rage was so violent that as I witnessed on one occasion he bit his own leg till the blood flowed Dogs shew what may be fairly called a sense of humour as distinct from mere play if a bit of stick or other such object be thrown to one he will often carry it away for a short distance and then squatting down with it on the ground close before him will wait until his master comes quite close to take it away The dog will then seize it and rush away in triumph repeating the same manœuvre and evidently enjoying the practical joke

We will now turn to the more intellectual emotions and faculties which are very important as forming the basis for the development of the higher mental powers Animals manifestly enjoy excitement, and suffer from ennui as may be seen with dogs and according to Rengger with monkeys All animal feel *Wonder* and many exhibit *Curiosity* They sometimes suffer from this latter quality as when the hunter plays antics and thus attracts them I have witnessed this with deer and so it is with the wary chamoi and with some kinds of wild ducks Brehm gives a curious account of the instinctive dread which his monkeys exhibited for snakes but their curiosity was so great that they could not desist from occasionally satiating their horror in a mo t human fashion by lifting up the lid of the box in which the snakes were kept. I was so much surprised at this account that I took a stuffed and coiled up snake into the monkey house at the Zoological Gardens and the excitement thus caused was one of the most curious spectacles which I ever beheld Three pecies of Cercopithecus were the most alarmed they dashed about their cages and uttered sharp signal cries of danger which were understood by the other monkeys A few young monkeys and one old Anubis baboon alone took no notice of the snake I then placed the stuffed specimen on the ground in one of the larger compartments After a time all the monkeys

when a wooden ball with which they were familiar as a plaything was accidentally moved in the straw under which it was partly hidden they all instantly started away These monkeys behaved very differently when a dead fish a mouse [12] a living turtle and other new objects were placed in their cages for though at first frightened they oon approached handled and examined them I then placed a live

[1] I ha e g e a b t acco nt f th r beha r n th occa n my *Exp* *f the Emotions* n *M and A al* p 43

large plate-glass wind w w re to dash himself ev n nce against t, h wo ld f a l g time aft rwards associate a hock with wind w fram b t erv diff re tly from th p k he w uld probably reflect n th n t re f the n.pedim t, and be ca ti under analo us circumstances. N w with m k s, as w shall prese tl see, painf l r m rely a disagreeabl impressi n, from an act n ce per f — m si ffi t to pre e t th

ase of man that similar diff re ce mp es th possessio of a fundam tally diff re t mi d

H uzea relates that, whilst crossin wid and arid plain in Texas, h tw d g s ff red gre tly from thirst, and th t between th ty and f rty tim th rushed d wn th h ll ws t search f w t These h ll ws w re n t all s, and th re w re tree in th m an th diff rence th g tat n, and as th re absol t l dry th re co ld h been m ll of damp arth. Th d gs beha ed as if tl y kn w that d p th gro d ff red tl m th best chance f fin ling t and H uz has ft tnessed th sam beha ur in th animals.

I h seen, as I daresa h th rs, th t h small bject thro n th gro d be d th reach f f th l pl ts n th Zool gical Gard ns, h bl w thro gh his trunk th gro nd bey nd tl bject, so that th curre t reflected all sid may dri th bject withi his reach. A ain w ll kn n tl logist, M W tropp inf rm m th t h observed in V una bear d l b t ly m kin th his paw rre t som w t which as close t th bar f hi cag so as to draw p ece of floati g bre d th hi reach. These act ns f tl l phant and bear can hardl be ttrib ted t m t t nl ted hal t, as th y ld be f little use t an mal in tat f nat re N w what th di f re ce betwee h actions, when pe formed t an ncult ted man, and by th h gh animals

Th sa and th d g h ft f d t at low l l, and th co ncid ce d h circumstances has becom associ ted in

their mi ds. A cult ated man w uld pe haps make som g e al proposition on th ubject but from all th t w kn w f sa a es t i ex trem l l btf l wh ther they would do so, and a d g certainly w uld n t. B t a sa age d w ll se rch t th sam w y

consc usly pla — w uld ppl t tl e el pl ant and th bear m ki g rent in the r w t Th sa ll certai l ne the kno n r are by

in l sl g t ham f ded t ns There w uld n d bt be th diff re ce b t ee h m and f tl h gl an mals, that h w uld take n tice f m cl l ght r circum tances and co d ti ns, nd w ld obse any con ect n betwe th m ft m ch l ss xperi ce and

n ss, w th l cl all sorts f bjects and sounds

exactly tl sam w y thi pow of assoc ti from th se l w n th scal ch as th pike, as w ll as in th t of draw g inf renc and f bse ti

Th promptu f reason, aft r y sh t experi nce, are w ll sh wn by the f ll w ac ti ns f Am rican m nk ys, wl ch tand l w in th rd R gg a m t caref l obsers t tes th t wh n l first g gg to his m nk y in l ar gu they mashed th m, and th s l t m ch f th co t nts aft ward tl y g tl hut d gainst som hard bod and p ked ff tl b ts of sh ll w th th fing rs Aft cutting th mselves l ce with any harp tool th y ld n t t h t ain, w ld handl t w th tl e gre t t ca t n. L mp f gar w ft n gi n tl m wrapped p in p pe and R gg som tim p t h wa p th p pe so that in hastily

Etude sur le Facultés Mentale de Anim ux, 18 2, om. ii. p. 265.

*Prof H xl y has nal sed with admirabl cl rness th m tal t ps by hich man, as ll as d g arri t concl in case nal gous t that gi my t t. See his art le Mr D rw Crit cs, the C tempor y Rev ew N 18 1 p. 462, nd in his Crit q nd Essay 18 3 p 2 9

to all strangers and I purposely tried his memory after an absence of five years and two days I went near the stable where he lived and shouted to him in my old manner he shewed no joy but instantly followed me out walking and obeyed me exactly as if I had parted with him only half an hour before A train of old associations dormant during five years had thus been instantaneously awakened in his mind Even ants as P Huber[18] has clearly shewn recognised their fellow ants belonging to the same community after a separation of four months Animals can certainly by some means judge of the intervals of time between recurrent events

The *Imagination* is one of the highest prerogatives of man By this faculty he unites former images and ideas independently of the will and thus creates brilliant and novel results A poet as Jean Paul Richter remarks[19] who must reflect whether he shall make a character say yes or no—to the devil with him he is only a stupid corpse Dreaming gives us the best notion of this power as Jean Paul again says The dream is an involuntary art of poetry The value of the products of our imagination depends of co

ay combination and to a certain extent on our power of voluntarily combining them As dogs cats horse and probably all the higher animals even birds[20] have vivid dreams and this is shewn by their movements and the sounds uttered we must admit that they possess some power of imagination There must be something

u oaying All dogs do not do so and according to Houzeau ... not then ... nt near ... imagi ... lines of ... b fore ... ir feel

... the faculties of the human mind it will I presume be admitted that *Reason* stands at the summit Only a few persons now dispute that animals possess some power of reasoning Animals may constantly be seen to pause deliberate and resolve It is a significant fact that the more the habits of any particular animal are studied by a naturalist the more he attributes to reason and the less to unlearnt instincts[22] In future chapters we shall see that some ... in ... unt ... lis ... at

... For instance Dr Hayes, in his work on *The Open Polar Sea* repeatedly remarks that his dogs instead of continuing to draw the sledges in a compact body diverged and separated when they came to thin ice so that their weight might be more evenly distributed This was often the first warning which the travellers received that the ice was becoming thin and dangerous Now did the dogs act thus from the experience of each individual or from the example of the older and wiser dogs, or from an inherited habit that is from instinct This instinct, may possibly have arisen since the time long ago when dogs were first employed by the natives in drawing their sledges or the arctic wolves, the parent stock of the Esquimaux dog may have acquired an instinct impelling them not to attack their prey in a close pack when on thin ice

We can only judge by the circumstances under which actions are performed whether they are due to instinct or to reason or to the mere association of ideas this latter principle however is intimately connected with reason A curious case has been given by Prof Mobius[23] of a pike separated by a plate of glass from an adjoining aquarium stocked with fish and who often dashed himself with such violence against the glass in trying to catch the other fishes, that he was sometimes completely stunned The pike went on thus for three months but at last learnt caution and ceased to do so The plate of glass was then removed but the pike would not attack these particular fishes though he would devour others which were afterwards introduced so strongly was the idea of a violent shock associated in his feeble mind with the attempt on his former neighbours If a savage who had never seen a

zac ue M dale d 4 ... n B ... re k I ... for tool r

ma r t n i p 136

[20] ibid 1872, t m i p 181

u j d Tl er t 18 9 p 11

larg plat glass and w w r to dash himself e nce against t, h w ld f l ng tim aft rwards assoc t shock w th a w ndow fram b t ry diff ntly from th p k he uld probably reflect n tl e t ire f the mpedim t, and be t und anal g us circumstances. N w with m nk ys, as w shall presentl see, a painf l r m rely a d sagreeabl impression from act n e per formed i som tim uffi t t p e t th an mal from epe ti g t. If w ttrib t thi d ff rence between the m k y and tl pik sol ly to th assoc ti f d as b g so m h tro g and m re persi te t in th than th th th gh th p k ft rece ed much th m re se re y ry can w mai tain n the ase f man th t a simil d ff re ce mpl th possessi n f f dam tally d ff rent m d

H ze relates th t, wuilst cross g n de rt and plain n T as, l two d g ff red gre tl from thirst, and th t b tween thi ty a d f rty times th y rushed d w th h llows t search f w t Tl e b ll w n re t d th re re n tree n th m r

tl m th best cl ance f fin ling w t and ll has ft w tn ssed th sam be l ur in th animals.

I h seen, as I d resay h th rs, th t l small bject thro n th gro d be ft reach f f th l pl t th

ol served V un b d l b t l m k th l p w rr t so w t wh ch as los t th b f hi cag so as t draw t ce f floati g b d th h reach These act f tl l pla t and bear can ha ll be ttr l ted t t t nl ted hal t, as th y ld be f l ttl se t an ar al tat f nat re N hat th diff rence betw e f act ns, h per f med b cult ted man, and by

trem l doubtf l wh th r th y and ld not. But a sa age, as w th seem or nc cons w ld appl t tl e l pl ant and t mak g cu nts n th a r water The sa ag w uld certai ly n th r kn n are by wh t l w th de ed m m nts were ffected y t his act w uld b gu ded by a rud process f reasoni as s rely wo ld a phil sopher in h s l ng t chai f ded ct s Tl re w uld ff re l etween h n and

tween th m aft m h less expe th f n am t importance I k pt a d l fants, old a was ness, w th whi h all so ts w re assoc ted t g tl r in l s m d com pared w tl tl t f tl e m t nt ll g t d g I e kn n But tl h h anim l d ff m actl tl sam w y n th pow of assoc ti n from th l w n th scal h as th p k as w ll as th t f d w ng nference and f bse t n

The prompt s f aso ft r ry h t men re re w ll hewn by tl f ll wi g ac

d th l t m h f th r co t nts aft

ca t L mp f gar w ft n g n th m w pped up in p pe and ft gg som t m p t h n p n th p pe so that n hastily

I Fud sur le Faculté Mentale des Anim ux 1 2, tom p 265

p. 462, nd his Crit q d E y 18 3 p.

unfolding it they got stung after this had *once* happened they always first held the packet to their ears to detect any movement within [26]

The following cases relate to dogs Mr Colquhoun[27] winged two wild-ducks which fell on the further side of a stream his retriever tried to bring over both at once but could not succeed she then though never before known to ruffle a feather deliberately killed one brought over the other and returned for the dead bird Col Hutchinson relates that two partridges were shot at once one being killed the other wounded the latter ran away and was caught by the retriever who on her return came across the dead bird she stopped evidently greatly puzzled and after one or two trials finding she could not take it up without permitting the escape of the winged bird she considered a moment then deliberately murdered it by giving it a severe crunch and afterwards brought away both together This was the only known instance of her ever having wilfully injured any game Here we have reason though not quite perfect for the retriever might have brought the wounded bird first and then returned for the dead one as in the case of the two wild ducks I give the above cases as resting on the evidence of two independent witnesses and because in both instances the retrievers after deliberation broke through a habit which is inherited by them (that of not killing the game retrieved) and because they shew how strong their reasoning faculty must have been to overcome a fixed habit

I will conclude by quoting a remark by the illustrious Humboldt.[28] The muleteers in S America say I will not give you the mule whose step is easiest but *la mas racional* —the one that reasons best and as he adds this popular expression dictated by long experience combats the system of animated machines better perhaps than all the arguments of speculative philosophy Nevertheless some writers even yet deny that the higher animals possess a trace of reason and they endeavor to explain away by what appears to be mere verbiage [29] all such facts as those above given

It has I think now been shewn that man and the higher animals especially the primates have some few instincts in common All have the same senses, intuitions, and sensations —similar passions affections and emotions, even the more complex ones, such as jealousy suspicion emulation gratitude, and magnanimity they practise deceit and are revengeful they are sometimes susceptible to ridicule and even have a sense of humour they feel wonder and curiosity they possess the same faculties of imitation attention deliberation choice memory imagination the association of ideas and reason though in very different degrees The individuals of the same species graduate in intellect from absolute imbecility to high excellence They are also liable to insanity though far less often than in the case of man [30] Nevertheless, many authors have insisted that man is divided by an insuperable barrier from all the lower animals in his mental faculties I formerly made a collection of above a score of such aphorisms, but they are almost worthless, as their wide difference and number prove the difficulty if not the impossibility of the attempt. It has been asserted that man alone is capable of progressive improvement that he alone makes use of tools or fire domesticates other animals, or possesses property that no animal has the power of abstraction or of forming general concepts, is self-conscious and comprehends itself that no animal employs language that man alone has a sense of beauty is liable to caprice has the feeling of gratitude mystery &c believes in God or is endowed with a conscience *I will hazard a few remarks on the* more important and interesting of these points

Archbishop Sumner formerly maintained[31] that man alone is capable of progressive improvement. That he is capable of incomparably

clearly shew that this animal possessed some reasoning power

[27] *The Moor and the Loch*, p 45 Col Hutchinson on *Dog Breaking*, 1850 p 46

[28] *Personal Narrative* Eng translat vol iii p 106

case of reasoning

[30] See Madness in Animals, by Dr W Lauder Lindsay in *Journal of Mental Science* July 1871

[31] Quoted by Sir C Lyell *Antiquity of Man*, p. 497

gre te and m re rap d impro m t than a
any oth r animal admits of no di p t and a
this s mainly d to h power f peaking and l
handing d wn h acquired kn wled With t
animals, looking first t the i di d al, ery
e who has had any xperi nce n settin
traps, kn w that v ung animals can be
ca ght m ch mo asily than ld nes and
th y can be m ch m re easily pproached by
an en my E n with respect to ld animals, t
is mpossible to catch many in th sam place
and in th sam kind f t p or t destroy
th m by th sam ki l f poison y t t im
probabl that all sh ld h partak n f the
poison, and impossibl tl t all sh uld ha e
bee ca ght in trap Th y must learn ca ti n
by seeing thei brethren ght poisoned In
N rth Am rica, wh re th fur b ari g animals
ha n re ed th y hib t, accord

ca
th re so l g carried n, th
possibly h com t pl y I h ece ed
se ral accounts th t wh n tel gr phs are first
set p any district, many b rd kill them
sel es by flyin against th wires, b t th t in
th course f a ry few years they l arn to
d this dang by seeing, as i w ld p-
pear thei com ad killed[32]

If w look to ccessi ge rations, to
the race th re is d bt th t b rd and th
animals g adually both acq re nd l se cau
tio relati to man tl nnes [33] and
th ti is ce tainly in ch f part an in
h rited hab t instinct b t part th re ult
of nd id al xperi nce A good observ Le-
roy [34] tates, that d tri ts h re f es are
m h h ted th g, first l g their
b rrows, are inco t tably m ch mo wary
tl an th ld n distri ts wh re th y are
not m h dist bed

Our d mest d gs ar d scended f m
l es an l jackals,[35] and th gh th y m y t
ha gai ed cunni g, and m y l lo t in
wari ess and usp n, y t th y h pro-
gressed in certain m al q lit es, ch as

F additional id ce th d t ls, see M. Houzeau, *Etudes su l Facultés Mentales de Ani- m ux* im 18 2, p 147

[33] See h re pect t b rds oceanic lands, m *J nal f Researche d g the l y g of th Be gle* 1845 p 398 *Orig f peci s*, th ed., p. 198.

Lett I hil. ur l'Intell g nc des A ma nou- *vel. Ed* 1802, p 86

[35] See the l nce this head chap. i., ol. i., *O th V ariation of A mals and Plants under Do- mestica. on.*

a o the mainu latter case ttributes
who desc bes these tw mm t o r the large
t

th hab tual rcise of all ts a
a di g xtirpati n by man as w ll as to
n arly all th less unn ng w ak mi ded
ats ha ing been conti usly de troy d by
him. It is h we r pos. bl th t th success f
the commo rat may be d e to ts h ving pos-
sessed greate unnin than its fellow peci s,
before it becam associ ted with man. To
maintain ind pe dentl of any direct e i
de ce th t no animal d n th course of
ages has progressed i tellect o oth r m tal
faculties, to be th q ti n f the e l
ti n of species. W h e seen that, according
to Lart t, xisting mammals bel nging to sev
eral rd rs ha e larg r b ains than th ir an

waln t, w th t e.
an American m nk y thu t b ak pen hard
palm ts and aft rwards f ts own ccord
d t t open the kind of nuts,

l

into a re ce, slip his hand to th oth nd
and use t in th proper man er as a l The
tamed el phants In ia are w ll kn wn to
break ff b anches f tree and use th m to
dri w y th fl and this sam act has been
obser ed in an l phant in tat f n tu [39]
I ha see y ung ang, wh n sh tl ght
she was g g t be wh pped co and protect
herself with blank t str w In these se
ral case t n and t cks w re mpl yed as
impl ments but th y are lik wise used as
w pons. Brehm[40] tates, n the thority of

Proceed g Zool gical Society 1864 p 186.

Sa ag and Wyma *Bosto Jou nal f Nat- ural History* ol 1843-44 p 383.

Sä gethier ro *Par guay* 18 0 ss. 51-56

[39] *The Ind F eld*, March 4 1871

Illustrierte Thierl ben, B i., ss. 9 82.

the well known traveller Schimper that in Abyssinia when the baboons belonging to one pecies (C gelada) descend in troops from the mountains to plunder the fields they some times encounter troops of another pecies (C hamadryas) and then a fight ensues The Ge ladas roll down great stones which the Hama dryas try to avoid and then both pecies making a great uproar rush furiously against each other Brehm when accompanying the Duke of Coburg Gotha aided in an attack with fire arms on a troop of baboons in the pass of Mensa in Abyssinia The baboons in return rolled so many stones down the moun tain some as large l that the t and the against the ... it deserves notice that these baboons thus acted in concert M W e on three mpanied by hes and the with every app arance of rage causing such a shower of missiles as effectually kept us from approach ing too near the tree As I have repeatedly seen a chimpanzee will throw any object at hand at a person who offends him and the before mentioned baboon at the Cape of Good Hope prepared mud for the purpose

In the Zoological Gardens a monkey which had weak teeth used to break open nuts with a stone and I was assured by the keepers that after using the stone he hid it in the straw and would not let any other monkey touch it Here then we have the idea of property but this idea is common to every dog with a bone and to most or all birds with their nests

The Duke of Argyll remark that the fash ioning of an implement for a pecial purpose is absolutely peculiar to man and he considers that this forms an immeasurable gulf between him and the brutes This is no doubt a very important distinction but there appears to me much truth S that

... its From this step it would be a small one to break the flints on purpose and not a very wide step to f ...

n

... of time which elapsed before the men of the neolithic period took to grinding and pol ishing their stone tools In breaking the flints, as Sir J Lubbock likewise remarks, parks would have been emitted and in grinding them heat would have been evolved thus the two usual methods of obtaining fire may have originated The nature of fire would have been known in the n ...

... for them elves temporary platforms but as many instincts are largely controlled by reason the imp er one such as this of building a platform might readily pass into a voluntary and con cious act The orang is known to cover its ... by throwing a straw mat over its head In these everal habit we probably see the first steps towards some of the simpler arts, such as rude architecture and dress, as they arose amongst the early progenitors of man

Abstraction General Conceptions Self-con sciousness Mental Individuality —It would be very difficult for any one with even much more knowledge than I possess to determine how far animals exhibit any traces of the e high mental powers The difficulty arises from the impossibility of judging what passes through the mind of an anim l and again the fact that writers differ to a gr at extent in the meaning which they attribute to the above terms, causes a further difficulty If one may judge from various articles which have been pub lished lately the greatest tress seems to be laid on the suppo ed entire absence in animals of the powe of abstraction or of forming gen eral concepts But wh n a dog sees anoth er dog at a distance it is often clear that he perceives that it is a dog in the abstract for wh n he gets nearer his whole manner suddenly changes if the oth r dog be a friend A recent writer re marks that in all such cases it is a pure as sumption to assert that the mental act is not essentially of the same nature in the animal as in man If eith r ref rs wh at he perceiv ith his en s to a mental concept th n so do both When I say to my t rrier in an eager voice (and I have ma le the trial many times) Hi hi where is it he at once takes it as a n that something is to b hunted and gener ally first looks quickly all around and then

'The Mal y Ar h pel g v l 1869 p 87
In l M 1869 pp 14 147
ul ch to c T m 1865 p 4 3 &c.

Mr Hookh n l tt to Prof M x Mull th B gl N w M y 18 3.

rushes into th nearest thick t, to scent f r any game, b t finding n thing, sh looks up int an ghbourin tree fo squirrel. N w d t these acti ns cl arly sh w that she had i rm ral l a or concept that

tı chase ...

consci usness. O th oth hand as Büchn r[43] has remarked, h w littl can the hard w ked wif of d graded Australian sa age wh uses rv f w abstract w rds, and cann t co t abo f ex rt h self-consci us ess, re-flect th nat re f h wn xist ce It is gen rall admitted, th t th hi h animals possess m m ry tt nti n, associ ti n, and som imaginati and reason. If these pow rs, wh ch diff m h in diff rent animals, are capabl of impro ment, th re seems no great mprobability in m re compl fac lties, uch as th hi h f rms f ab tracti n, and self-consci us ess, &c., h ing been l ed thro gh th d l pm t and comb nati n f th impl es. It has been urged against the h re maintained th t t mpossibl to sa t what point th asce di g scal ani mals becom capabl f ab tracti n, &c. b t who can sa t wh t g this occurs ur ung hildre ? W see t l ast that ch pow rs are d loped in children by imperceptibl degrees.

Th t nimals retain their m tal indi d al t isunq est nabl Wh my vo ce wak ed tra of ld associ t ns in th mind f th before-m t d d g, h must ha retai ed his m tal individual t alth gh ry t m of hi brai had probably nd g chan e more than nce duri th int rval f fi ars. This d m ght h brought f rward th argument lat l ad anced t crush all l tionists, and said, I abid amid all m n tal moods and all mat rial hanges. Th teachi g that t ms le th ir impressi as legacies to th toms fall g t th places th ha acated is co tradict ry of th tt ance of consciou n s, and th ref re f lse t t th teach necessitated by l

ti nism consequently th h pothesis is a false n [44]

La g g.—This faculty has justly been con d red as o f th cl ef di tincti be-tween man and the lowe animals. B t man as h ghly compet nt judge Archbish p Whate-ly remarks, is n t th al animal th t can make use f langu ge to xpress what is pass-ing in his mind and can u d rstand m re or less, wh t s so expressed by an th r [45] In P ... th C ... h n xcited utt s

are und rstood y us, and ...

stand o rs, as Rengg r and th rs declare. It is a m re remarkable fact that th d g si ce being d mesticated, has learnt to bark[46] n t t f fi disti ct to es. Alth gh

distin t f demand pplicati n, as wh n wishing f doo o wind w to be pened According t H uze wh paid parti lar tt nti n to th ubject, th d mestic f wl utt rs t l ast d zen significant so nds.[48]

Th habit al use f articulat languag is, h w peculiar to man b t l uses, in com m n w th th low animals, inarti ulat cri s

of pain, f ar rprise ang tog th with thei pproprı t acti ns, and th murmur of a m th to h bel ed child are more expres-si than an w rds. That which distinguishes man from th l w animals n t th und tandin of articulate sounds, for as ry kn ws, d und rstand many w rds and se

[43] *Conférence sur la Théorie Darwinienne*, French transla 1869 p. 132.

[44] The Re D J M Cann, *Anti-Darwi sm*, 1869 p. 13

[45] Quoted in *Anthropological Review* 1864 p. 158.
Rengg *bid* s. 45

[46] See my *V riatio f A mals and Plants nder Domest cation*, ol. i., p. 27
Facult Mentale d A maux tom ii., 18 2, p. 346-349

[48] See discussio this subject in Mr E. B. Ty lor ry t resting w k, *Researches nto the E rly History f Mankind*, 1865, chaps. ii. t

tences In this respect they are at the same stage of development as infants between the ages of ten and twelve months who under stand many words and short sentences but can not yet utter a single word It is not the mere articulation which is our distinguishing charac ter for parrots and other birds possess this power Nor is it the mere capacity of connect ing definite sounds with definite ideas for it is certain that some parrots which have been taught to speak connect unerringly words with things and persons with events [52] The lower animals differ from man solely in his al most infinitely larger power of associating together the most diversified sounds and ideas and this obviously depends on the high devel opment of his mental powers

As Horne Tooke one of the founders of the

not a true instinct for every language has to be learnt It differs however widely from all ordinary arts for man has an instinctive tend ency to speak as we see in the babble of our young children whil t no child has an instinc tive tendency to brew bake or write More over no philologist now supposes that any language has been deliberately invented it has been slowly and unconsciously developed by many steps [53] The sounds uttered by birds offer in several respects the nearest analogy to

[5] I have recei ed e eral deta led ccou t t this eff t. Admiral S r B J Sulivan wh m I k ow t be

to persons rr g nd good bye ld f ll w to tho d n rti g I could a ld eral th uch ca

the further consequences of the act.

lan uage for all the members of the same pecies utter the same instinctive cries expressive of their emotions and all the kinds which sing exert their power instinctively but the actual song and even the call notes, are learnt from their parents or foster parents These sounds, as Daines Barrington[54] has proved are no more innate than language is in man. The first attempts to sing may be compared to the imperfect endeavour in a child to babble The young males continue practising or as the bird catchers say recording for ten or eleven months Their fir t essays show hardly a rudiment of the future song but as they grow older we can perceive what they are aim ing at and at last they are said to sing their song round Nestlings which have learnt the song of a distinct pecies as with the canary birds educated in the Tyrol teach and transmit their new song to their off pring The slight natural differences of song in the same species inhabiting different di tricts may be

stinctive tendency to acquire an art is not peculiar to man

With respect to the origin of articulate lan guage after having read on the one side the highly interesting works of Mr Hensleigh Wedgwood the Rev F Farrar and Prof Schleicher [55] and the celebrated lectures of Prof Max Müller on the other ide I cann t doubt that language owes its origin to the imi tation and modification of various natural sounds, the voices of other animals and man s own instinctive cries aided by signs and gestures When we treat of sexual selection we shall see that primeval man or rather some early progenitor of man probably first used his voice in producing true musical ca lences, that is in singing as do some of the gibbon apes at the present day and we may conclude from a widely pread analogy that this power would have been e pecially exerted during the

[54] Hon Dain Barringt n in *Ph losoph. T ac- tio* 1 3 p 262 See al D reau d la M ll in *A n des S Nat* 3rd seri s, *Zoolog* t m p 119

[55] O h Orig f L g g b H Wedgwood

co rtship of the sexes,—w uld h xpressed an us m t ns, s h as l je l y tri umph,—and w ld hav se ed as a chall g t n ls It is, th ref re probable that th mitat n f mus cal n s by art culate sounds m l m rise to w rds xp ss e f

f llow and sin e f wls gi dist t wa m gs f dang n the gro d r n the ky fr m h k (both as ll as thi d cry i t ll g ble

t tu pec ou bee fi t t p th f m ti f lanwu g

act d th pow f p ech B t tl el t n l t ce tl co ti ed se f l g age and th d l pm t f tl b l as n d bt bee f m mpo tant The m ntal po rs in som early prog nit f m n m t h bee m h gl ly d l ped th ai y existi g pe, bef n th m t mperfect f m of speecl co ld h com to se b t w m y confid tly b l th t the co t ed use and ad ancem t f thi po w ld h re acted th m d tself by n bl g d o g g t t ca y lo g t ains f th ght. A compl t f th ght can m re b ried th t tl aid f w rd wh th r pok sil t, than l g al l t w th t th se f figure lg b It ppe s, also tl t an din y t ai f th ght lin t equires, g tly facil tated by som f rm f la gu g f th d mb d af and bl d gi l La B dgman, was bse ed to use h fing rs wh lst dre m g the

l ss a l ng s ccessio f vi id and connected id as may pass through the mind with ut tl aid of any fo m of language as we m y i f r f m the m em nts f dogs d ri g th ir dre ms We ha also een tl at animals are ble to r aso to certain e te t, man f stly with ut th a d of langu g The nt m t con e ti n b tw en th b a as it is n w de l ped n us, and tl e faculty of peech is w ll hewn by th se uri us case f b ain-disease in whi h peech s pec ally affected as wh n th pow r to rem mber ub tant s s lo t

tal d ocalo gansl adin t nh ited chang s in th ir t ct re a d f n t ons, than in tl case f hand w iti wh ch depends partly on the f rm of th hand nd p tly n tl d po i ti n f th m d and handwrit g i ce t inly inh rited[21]

S e l write m re pecially Prof Max Müll [22] h l t ly ins ted th t th use of l ngu g impl es the pow f f ming g n l co cept d th t as no animals ar supposed t possess thi pow an mpassabl barri is f rmed b tween them d man[23] W th r pect to anim ls, I ha al ady e d a red to

so ofte q ted, by Brehm nd Re gg

Il use gi es ry cu ious ceo t f his b serv t ons th bject his *Facultés Mentales de Anima* t m i., p 348.

[21] See remarks th h ad by D M dsl y *The Physiology and Pathology of M nd*, 2nd ed 1868, p. 199

1873

guage, 1873 third lecture) this ph ism "Th re is tho ght th t rds, as littl as th are w rds th t th ght. Wh t tra g definiti must h re be g t th w rd th ught!

tences In this respect they are at the same stage of development as infants between the ages of ten and twelve months who under stand many words and short sentences but can not yet utter a single word It is not the mere articulation which is our distinguishing charac ter for parrots and other birds possess this power Nor is it the mere capacity of connect ing definite sounds with definite ideas for it is certain that some parrots which have been taught to speak connect unerringly words with things and persons with events [52] The lower animals differ from man solely in his al most infinitely larger power of associating to gether the most diversified sounds and ideas and this obviously depends on the high devel opment of his mental powers

As Horne Tooke one of the founders of the

not a true instinct for every language has to be learnt It differs however widely from all ordinary arts for man has an instinctive tend ency to speak, as we see in the babble of our young children whilst no child has an instinc tive tendency to brew bake or write More over no philologist now supposes that any language has been deliberately invented it has been slowly and unconsciously developed by many steps [53] The sounds uttered by birds offer in several respects the nearest analogy to language for all the members of the same spe cies utter the same instinctive cries expressive of their emotions and all the kinds which sing exert their power instinctively but the actual song and even the call notes, are learnt from their parents or foster parents These sounds, as Daines Barrington [54] has proved are no more innate than language is in man The first attempts to sing may be compared to the imperfect endeavour in a child to babble The young males continue practising or as the bird catchers say recording for ten or eleven months Their first essays show hardly a rudiment of the future song but as they grow older we can perceive what they are aim ing at and at last they are said to sing their song round Nestlings which have learnt the song of a distinct species as with the canary birds educated in the Tyrol teach and trans mit their new song to their offspring The slight natural differences of song in the same species inhabiting different districts may be

the languages of distinct races of man I have given the foregoing details to shew that an in stinctive tendency to acquire an art is not peculiar to man

With respect to the origin of articulate lan guage after having read on the one side the highly interesting works of Mr Hensleigh Wedgwood the Rev F Farrar and Prof Schleicher [55] and the celebrated lectures of Prof Max Müller on the other side I cannot doubt that language owes its origin to the imi tation and modification of various natural sounds the voices of other animals and man s own instinctive cries aided by signs and ges tures When we treat of sexual selection we shall see that primeval man or rather some early progenitor of man probably first used his voice in producing true musical cadences that is in singing as do some of the gibbon apes at the present day and we may conclude from a widely spread analogy that this power would have been especially exerted during the

[53] See som good r m rks on this h ad by Prof Whit ey in his *Ori ntal nd L g ist c St d* 1873 p 354 He observes that th d ire of comm ca t on betwe n m n is the li ing f rce which in the de el pment of la guage w rks both cons usly a d unconsciously consc usly as g rds th im m d t e l to be attained u consci usly as regards the further consequences of the act.

[54] H Dai B rri gt *I h losoph T ac tions* 17 3 p 262 See l Dure u de l M ll in 4 d Sc N t 3rd r *Zoolog* t m x p 119 ... H W dgwood

ease f rms are con tantly gai ing tl upper hand and th we the r uccess to th ir wu inhere t rt To these m re mportant causes f the surv al f certai w rds, m re m be added f th re

Th perfectl regular and w n ple l m r of man ba a gu ti of th ir f und rs. Th F on Schl g l writes In those lang g which ppear to be t th l w t grad f t llectual ulture w freq ntl bserv erv hi h and l b orat degree of art th gramm t al true t re Th especiall th ase w th the Basq and th Lapponian, and man f the Am rican langu g s."[1] B t t assuredl an rro t peak f an langu g as an art n th

and as h w rd express th most b us relati ns betwee object and perso s, t is n t rpri g th t th sh ld ha bee used by th m of most races d ri g th arl t s. W th respect to perfecti tl f ll llus t ti ll be t sh w h asil w m rr a crinoi d som times co ts f n l ss than 1 0 000 p eces of h ll[2] all arranged w th pe fect mm try rad t g lines b t t talist doe t con d n animal f tl ki d as more pe fect than b lat ral w th com parat l f w parts, and w th f these part al k cept g th ppo it sides of th bod H j tl consid rs th diff re tia tion and pecialisat f rgans as th t t of perfect n. So with langu es th most m m trical and compl ght n t t be ranked abo rregular abbre ted and bastard sed langu ges, whi h ha borrowed xpressi rd and useful f rms f constru ti n from ari co q ring, co qu red mmigrant races.

From these f w and imperfect remark I conclud th t th trem ly complex and reg ular constructi of many barbarous lan guages, is no proof that they w thei rigin

to a seen, tself tl r an l ef th t man has been de l ped from some l we f rm

S e f B a ty.—Th s sense has been de clared i nec l t man I refe h re nly t th forms

d d c birds, pla th bea t f l m l partne As w men e rywh re deck th mselv with these plum s, th be t of u h rnaments cannot be dis p ted As w shall ee lat r the nests of humm g b rds, and the pla ing passag f bo b rds are tast full rnam ted w th gail -col ured object and th shews that th n t rece e som ki d f pl asure from th i ht of u h thi gs. With th great ma

g th seaso f lo are ce tainly adm red b y th f m l s, f which fact d nce w ll

th latt n d pl y th harm bef re th f males w ld h been thrown aw y and thi t is mpossible to dmit. Why certain bright colo rs sh uld cit pl as re cann t, I pre m be plai ed any m re th n why certain fla rs and sce ts are gree bl b t h b t has som thing t d with th result, f r th t wh ch i at first unpleasant t ur se ses, ult m t ly becom pl asant, and hab ts are inh rited W th re pect t so nds, H lmh ltz has plai ed t ce tain t t n ph o l gical principl s, wh harm ni s and certain cad nces are gree bl B t besid s this, sound freq tl recu ring t i regular inter als are highl disagree bl as ery n will adm t wh has list ned t night to th irregu lar flappin of a rope on board ship. The same

[1] Quoted by C S. Wak *Chapters on M n*, 1868, p. l l

[2] Buckland, *Bridgewater Treatise* p. 411.

[3] See som good remarks th simplificat f languages, by ir J Lubbock, *Orig of C vilisation*, 18 0, p. 278.

shew that they have this power at least in a rude and incipient degree As far as concerns infants of from ten to el ... nd ... hat ... ds ... general ideas as quickly as they do unless such ideas were already formed in their minds The same remark may be extend ed to the more intelligent animals as Mr Leslie Stephen observes [64] A dog frames a general concept of cats or sheep and knows the corre ponding words as well as a philoso pher And the capacity to understand is as good a proof of vocal intelligence though in an inferior degree as the ca ... I

... other organs it is not difficult to see Ants have considerable powers of inter communication by means of their antennæ as shewn by Huber who devotes a whole chapter to their language We might have used our fingers as efficient instruments for a person with practice can report to a deaf man every word of a speech rapidly delivered at a public meeting but the loss of our hands whilst thus employed would have been a serious incon venience As all the higher mammals possess vocal organs constructed on the same general plan as ours and used as a means of communi cation it was obviously probable that these same organs would be still further developed if the power of communication had to be im proved and this has been effected by the aid of adjoining and well adapted parts namely the tongue and lips [65] The fact of the higher apes not using their vocal organs for peech no doubt depends on their intelligence not having been sufficiently advanced The pos session by them of organs which with long continued practice might have been used for peech although not thus used is paralleled by the case of many birds which possess organs fitted for singing though they never sing Thus the nightingale and crow have vocal organs similarly constructed these being used by the former for diversified song and by the latter only for croaking [66] If it be asked why apes have not had their intellects developed to the same degree as that of man general causes only can be as igned ... t

... of development through which each creature has passed

The formation of different languages and of distinct pecies an l the proofs that both have been develope l through a gradual process, are curiously parallel [67] But we can trace the f r mation of many words f ... t

... s

... tinct languages striking homologies due to community of descent and analogies due to a similar process of formation The manner in which certain letters or sounds change when others change is very like corre lated growth We have in both cases the re duplication of parts the effects of long-con tinued use and so forth The frequent presence of rudiments both in languages and in pecies, is still more remarkable The letter *m* in the word *am* means *I* so that in the expression *I am* a superfluous and useless ru liment has been retained In the pelling also of words, letters often remain as the ru liments of an cient forms of pronunci ... I

... to descent or artificially by ot er characters Dominant lang ... s

... reappears The same language never has two birth places Distinct languages may be crossed or blended together [68] We see varia bility in every tongue and new words are continually cropping up but as t ere is a limit to t e powers of the memory single words, like whole languages gra lually become ex tinct As Max Mülle has well remarked —
A struggle for life i con tantly going on amongst the wor ls and grammatical forms in each language Th e better ... !

[64] *Ess y F Th k g d* 1873 p 82
[65] See s m good remarks to this ffect by Dr M ud l y *The Phy iology nd Pathology f M nd,* 1868 p 199
[66] Ma gilli ray *H t f Brit h B ds* v l i 1839 p 29 An celle t bserv r Mr Bl ckw ll rem ks that the magpie l rns to pro u ce gl w rds, and e n sh t nte ces m re d ly than lmost any other British bird yet as h adds, aft r lo g ...

... gy 1853 ...
[67] See tl ry nt ti g par ll l m bet ee tl d l nt f pec s n l l ngu g s, b C L y ll *Th G ol gical Evid nc f th Ant q ty f M n*, 1863 ch p x
[68] See rem k t tl is ffect by th R F W F rr ... t ... g art l ... tled ... D rw ism *Nat e* M rch 24 18 0 p 528
[69] *Nat* J nu ry 6 18 0 p ...

imagination, curiosity reason, &c., had been fairly well d el ped in the mind of man, his dreams would not ha led him to beli ve in spirits, an, more than in th case of a dog.

The tendency in savages to imagine that natural objects and agencies are animated by spiritual or living essences, is perh.ps illustrated b little fact which I once noticed my dog, a full-grown and very sensible animal, was lying on th lawn during a h t and still day but at little distance slight breeze occasi nally mo ed an pen parasol, which w uld have been wholly disregarded by the dog, had any one stood near t. As t was, ery tim that the parasol slightl mo ed, the do growled fiercely and barked. He must, I think, have reasoned to himself in rapid and unconscious manner that mo ement without any pparent cause indicated th presence of some strange living agent, and that no stran had a right to be on his territory

The belief in spiritual agencies would easily pass into the belief in the existence of one or more gods. For sa ages w uld naturall attribute to spirits the sam passions, th sam lo of engeance o simplest form of justice and the same affections which they themsel es feel. Th F egians ppear to be in this respect in an intermediate conditi n, f when the surgeon on board the *Beagle* shot some oung ducklings as specimens, Y rk Minster d clared in the most solemn manner "Oh, Mr Bynoe, much rain, much snow blow much and this was va ntl retrib ti punishment for wasting human food. So again h re lated how when his broth killed wild man, storms long raged, much rain and snow fell. Y t w could disco that the Fuegians belie ed in what w should call a God, or practised any religious rites and J mmy B tton, with justifiable pride, sto tl maintained that th re was no d vil in his land. This latter assertion is the more remarkable, as with savages the belief in bad spirits is far more common than that in good on s.

The feeling of religious d otion is a highly complex one, consisting of love, complete submission to an exalted and myst r us perso a strong sense of d pendence f ar rev rence gratitude, h pe fo the f ture, and perhap oth r elem nts. N being could experi nce so complex an moti n until ad anced in his intellectual and m ral faculties to at least a mod rately high le el. N erth less, w see som distant pproach to this state of mind in the deep lo of dog fo his master associ ted with compl te submissi n, som f ar and perhaps ther feelings. Th behaviour of a d wh n returning to hi master after an absence and, as I may add, of a monkey t his beloved keeper is wid ly differe t from that towards their f llows. In th latter case the transports of r nne to be som wh t less, and the

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in ...

long as his reasonin powers remained poorly d v loped, to vari us strange superstitions and

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superstitions, f they sh w us what an infinite debt of gratitud w we to th impro ement of our reason, to science, and to our accumulated knowledge. As Sir J Lubbock has w ll observed, " t is not too much to say that the horrible dread of unkn wn vil hangs lik a thick cloud over savage life, and mbitters ery pleasure." These miserabl and indirect consequences of our highest faculties may be compared with th incidental and occasional mistakes of th instincts of th lowe animals.

He then further shews that names or nicknames given from some animal or other object, to the early progenitors or founders of tribe are supposed after long interval to represent the real progenitor of the tribe and such animal or object is then naturally believed still to exist as pirit, is held sacred, and worshipped as god. Nevertheless I cannot b t suspect that there is still earlier and ruder stage hen anything hich manifests power or mo eme t is thought to be ndowed with some form of life, and ith mental faculties analogous to our own.

Journal of Mental Science, 1871, p 43) that Bacon long ago, and the poet Burns, held the same notion.

Prehistoric T mes, 2nd ed., p. 571. In this work (p. 571) there will be found an excellent account of the many strange and capricious customs of savages.

principle seems to come into play with vision as the eye prefers symmetry or figures with some regular recurrence Patterns of this kind are employed by even the lowest savages as ornaments and they have been developed through sexual selection for the adornment of some male animals Whether we can or not give any reason for the pleasure thus derived from vision and hearing yet man and many of the lower animals are alike pleased by the same colours graceful shading and forms and the same sounds

The taste for the beautiful at least as far as female beauty is concerned is not of a special nature in the human mind for it differs widely in the different races of man and is not quite the same even in the different nations of the same race Judging from the hideous ornaments and the equally hideous music admired by most savages it might be urged that their æsthetic faculty was not so highly developed as in certain animals for instance as in birds Obviously no animal would be capable of admiring such scenes as the heavens at night a beautiful landscape or refined music but such high tastes are acquired through culture and depend on complex associations they are not enjoyed by barbarians or by uneducated persons

Many of the faculties which have been of inestimable service to man for his progressive advancement such as the powers of the imagination wonder curiosity an undefined sense of beauty a tendency to imitation and the love of excitement or novelty could hardly fail to lead to capricious changes of customs and fashions I have alluded to this point because a recent writer [3] has oddly fixed on Caprice as one of the most remarkable and typical differences between savages and brutes But not only can we partially understand how it is that man is from various conflicting influences rendered capricious but that the lower animals are as we shall hereafter see likewise capricious in their affections aversions and sense of beauty There is also reason to suspect that they love novelty for its own sake

Belief in God—Religion —There is no evidence that man was aboriginally endowed with the ennobling belief in the existence of an Omnipotent God On the contrary there is ample evidence derived not from hasty travellers but from men who have long resided with savages, that numerous races have existed and still exist who have no idea of one or more gods and who have no words in their languages to express such an idea [74] The question is of course wholly distinct from that higher one whether there exists a Creator and Ruler of the universe and this has been answered in the affirmative by some of the highest intellects that have ever existed

If however we include under the term religion the belief in unseen or spiritual agencies the case is wholly different for this belief seems to be universal with the less civilised races Nor is it difficult to comprehend how it arose As soon as the important faculties of the imagination wonder and curiosity together with some power of reasoning had become partially developed man would naturally crave to understand what was passing around him and would have vaguely speculated on his own existence As Mr M'Lennan[75] has remarked Some explanation of the phenomena of life a man must feign for himself and to judge from the universality of it, the simplest hypothesis and the first to occur to men seems to have been that natural phenomena are ascribable to the presence in animals, plants and things and in the forces of nature of such spirits prompting to action as men are conscious they themselves possess It is also probable as Mr Tylor has shewn that dreams may have first given rise to the notion of spirits for savages do not readily distinguish between subjective and objective impressions When a savage dreams, the figures which appear before him are believed to have come from a distance and to stand over him or the soul of the dreamer goes out on its travels and comes home with a remembrance of what it has seen [76] But until the faculties of

[73] *The Spectator* Dec. 4 1869 p 1430

Tl W l; f A m ls d Il nt in tl

v n us gifts d ce m ies, nd ts d i v ked

behind t erv vivid impressi n. It is cl ar that many instincti e d sires, su h as th t f hunge are in their nature f sh rt durati n and aft being satisfied, are n t readil or vi xill recalled. *Thirdly* aft th pow r of lang ge had bee acquired and th wish of t.. communit could be xpressed th com mo pinio h w each m mber ou,ht to act f th p bl c good, w uld nat rall becom in paramou t d rree th guide to acti n. But t hould be born in mind that howe r great we -ht w ma ttrib te t p bl c pini n, our regard f th pprob ti n and d sapprobation of ur f low u pend mpath which, as w uall see f rms an ssential part f th so- al nstinct, and indeed ts f und t t *Lastly* hab t in th nd nd al w ld lt m t lv f la rs important part in guid th con duct of each m mbe f th social nstin t, t r l with mpath is, lik an th in

social anim l, would gain in our supposed case as t ppears to me, som feeling f right r wro g, o a consci nce. For ach indi dual would ha an ward sense of po sessing ce tain more enduring nstincts, and oth wo l sh uld be fact n, n misery would be f lt, as past impressi ns w re compared during their ces- sant passa,e thro ,h th mind In this case an inward m nit would t ll th animal th t t wo ld ha been bett to ha e followed th on imp lse rath than th oth Th e course ,ht t h ve been f llowed and tl oth ht n t th one w ld ha been ri ht nd the tl e wrong but to th se t rms I hall recur

Soci ll ty — Animals of many kind are so- ci l w find d tin t species living to-

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ral subord nat proposit mu t n w be dis- cussed, and som of th m t consid rabl length

It m be w ll first to premise that I d n t ish t maintain that an strictl social ani mal f ts t llect al facult es w re t becom as acti and as highl d loped as in man, ould acquire exactl th sam m ral sense as ours. I th sam mann as ari animals ha som sense f be t th gh th d mire wid l differe t objects, so th might h sense of ri ht and wro ,, th h led b t t f llow wid l diff rent lines f cond ct. If f instance to take an xtrem case m n re re red und precisel th sam condi t n as hi -bees, th re can hardl be d bt that nmarried f males would, lik th ork bees, think t sacred d t t kill th ir brothers, and m th rs w ld tri to kill thei fert le d t rs and n o w uld think of int rfer N rth l ss, th bee any th

Mr H. Sidgwick remarks, in able discussi ... t ject the Academy June 15, 1872, p 231) ... superior bee w ma feel sure w uld a pure t ... so of the popular question. Judging, however from the habi of many or most savages, m ... the problem t f male inf ticide po

lo f tl d g whi h tl d returns w th int re t. E ry o must ha n ticed l w miserabl h rses, d gs, heep, &c. are wh n separated from th compani ns, and what tro g m tual affecti n th two f rm kinds,

mals and pass nsects, altho h som f th se are social and aid an th n man important w s. Tl mo t comm n mutual serv ce in th high animal is t warn o an oth f dan b mean f th united sense of all. E ry port man kn ws, as D J remarks, h w diff cult t t pproach ani mals in h rd troop. Wild h rse and cattl d not, I beli v mak an dan sign l but th attit d f an of th m who first dis- co rs an m warns th th rs. Rabb ts

she ov looks th f ct, which she would doubtless admit, that the in tincts of the bee ha bee ac- quired for the good of the communit h goes so far as t sa that if the theory of thics l ocated in this hapt were enerall ccepted I cannot b t belie that in the hour of their triumph would be so nded the knell of the virtue of mankind It is t be hoped that the belief in the permanence of virtue on this earth is not held by ma pers ns n so we k t ure

Die Darwin sche Theori s. 101

CHAPTER IV

COMPARISON OF THE MENTAL POWERS OF MAN AND THE LOWER ANIMALS (*Continued*)

I — of those differences he moral s c or conscience is by far the most important This sense as Mackintosh[2] remarks has a rightful supremacy over every other principle of human action it is summed up in that short but imperious word *ought* so full of high significance It is the most noble of all the attributes of man leading him without a moment s hesitation to risk his life for that of a fellow creature or after due deliberation impelled simply by the deep feeling of right or duty to sacrifice it in some great cause Immanuel Kant exclaims Duty! Wondrous thought that workest neither by fond insinuation flattery nor by any threat but merely by holding up thy naked law in the soul and so extorting for thyself always reverence if not always obedience before whom all appetites are dumb however secretly they rebel whence thy original [3]

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y

c passing it over and because as far as I know no one has approached it exclusively from the side of natural history The investigation possesses also some independent interest as an attempt to see how far the study of the lower animals throws light on one of the highest psychical faculties of man

The following proposition seems to me in a high degree probable—nam

being here included would inevitably acquire a moral sense or conscience as soon as its intellectual powers had become as well or nearly as well developed as in man For *firstly* the social instincts lead an animal to take pleasure in the society of its fellows to feel a certain amount of sympathy with them and to perform various services for them The services may be of a definite and evidently instinctive nature or there may be only a wish and readiness as with most of the higher social animals, to aid their fellows in certain general ways. But these feelings and services are by no means extended to all the individuals of the same species only to those of the same association *Secondly* as soon as the

of dissatisfaction or even misery which invariably results as we shall hereafter see from any unsatisfied instinct would arise as often as it was perceived that the enduring and always present social instinct had yielded to some other instinct at the time stronger but neither enduring in its nature nor leaving

the p gnant qu Ought
di p t d qu

Se fo nst. n on th s bj ct, Qu t f ges *U té de l'I pèce H m* 1861 p 21 &
D ertat o Eth al I I l phy 183 p 231 &c
M taphy c f I th t anslated by J W Semple Ed bu gh 1836 p 136

1865 p 481) qu

ad led
Sir B Brod animal (*P ychologi al E q* 1854 p 19) Ks of M Mill

F) ans, wh wh n the r pare ts get ld r fall ill, bury them ah [12]

Many an mals, h we e ce tainly mp t h h d t d g r Tl s

...

companions M Blyth as I e inf rms m Indian ro f ed ng tw o three f th e m pani h w bl l nd I ha heard f an anal g s ase w th th d m t cock. W m y if hoose call th se ti n in ti e t b t h asc are m ch too ar f th d el pment f any pecial instin t. I h e myself ee d g wh ne passed cat wlo lay k in bask t, d was g eat f d of his, tho t g g h r f w l cks w th hi to gu th t g of ki d f l g a d g It m t b called ympathy th t l ad a cou ro s d g t fly t any wh trik h

mpe

was it was eally path tic t se h w per se n gly l t ed t l k h must s f ce d co f rt h B l m[13] tat th t wl n baboo co fin m t was p rs ed t b p n l ed th tl tried to protect him It m t h bee ymp thy n th cases bo g n l h led th b boon and Cercop tl ec t de- f d th y g com ad from th do s and th ea l I w ll g nly tl instance f mp th t and h ro co l t, n tl e case f littl Am rican m k y Se al y rs g keepe t th Zool g l G rd l d m som deep and se reely l led w d th pe f l wn eck, fli ted h m wl l t k ecl g tl floo by fi ce b boon Tl l ttl Am rican m k y wh was warm f f tl keepe i ed th sam com partm t, and as d adf lly af d f th gre t b boo N rtl l ss as soo as f w his fri d peril h ru hed to th r scu d

by screams and l t so di t acted th baboon th t w ble to escape, aft r as tl e s g B tl tin

I agre w th Agassiz that d g possess som thing ry l k a conscien e

Dogs possess some pow r f self-command and th s doe n t appea to be wh lly tl e re s lt of f r As B ubach remarks, they w ll refrain f om te l g food in the abse ce of t Th h e long bee accepted as

to de th But th dri himself as Dr Hooke was as. red ran n ri k. Th f bearance u d an m g y so dreadful f a h vy anim l s a w nd rf l proof f n bl fidel ty

All anim ls h g n a body wh ch d f d tl msel tta k the nemies n ncert m t nd ed b in some d gree faithf l to ne an tl and thos th t f ll w a leade mu t

n says,[20] th t tl y can t d re e n a m m t y par t n from th h rd Tl y ar sse t all l l a d accept th comm n

th se anim ls f harm ss, w tch assid u ly f those wh by graz g p rt h w lf

[12] J L bbock, P histori T mes 2 d ed p 446

[13] As q ted by M L H Morgan, *The America B er* 1868, p 272 Capt Stansbury lso gi int rest g acco t f th m in hich y g pelican, carried w y by tro g tr am was gu led nd neou ged ts tt mpts to ach the hore t y half doze ld b rds

[14] As M B in tat s, Effect aid t uff re sp gs from ympathy proper *Mental nd Moral Science* 1868, p 245

Illustrierte Thierleben, B i, 85

D TE pe t de l Cl 1869 p 97

Die D ut sche Art Leh 1869 s. 54

See also Hook *H mal y J nals*, I u. 1854 p 333

Brehm, *Illustrierte Th l ben*, B i, s. 6

[20] See his trem ly t estu g paper Gre- gari us ess C tt d M n, *Macmill Magazine*, F b 1871 p 353

stamp loudly on the ground with their hind feet as a signal sheep and chamois do the same with their forefeet, uttering likewise a whistle Man
nels
ally t
monkeys acts as the sentinel and utters cries expressive both of danger and of safety [8] Social animals perform many little services for each other horses nibble and cows lick each other on any spot which itches monkeys search each other for external parasites and Brehm states that after a troop of the *Cercopithecus griseo viridis* has rushed through a thorny brake each monkey stretches itself on a branch and another monkey sitting by conscientiously examines its fur and extracts every thorn or burr

Animal al o render more important services to one another thus wolves and some other beasts of prey hunt in packs and aid one another in attacking their victims Pelicans fish in concert The Hamadryas baboons turn over stones to find insects &c and when they come to a large one as many as can stand round turn it over together and share the booty Social animals mutually defend each other Bull bisons in N America, when there is danger drive the cows and calves into the middle of the herd whilst they defend the outside I shall also in a future chapter give an account of two young wild bulls at Chillingham attacking an old one in concert and of two stallions together trying to drive away a third stallion from a troop of mares In Abyssinia Brehm encountered a great troop of baboons who were crossing a valley some had already ascended the opposite mountain and some were still in the valley the latter were attacked by the dogs but the old males immediately hurried down from the rocks and with mouths widely opened roared so fearfully that the dogs quickly drew back They were again encouraged to the attack but by this time all the baboons had reascended the height except ing a young one about six months old who loudly calling for aid climbed on a block of rock and was surrounded Now one of the largest males a true hero came down again from the mountain slowly went to the young one coaxed him and triumphantly led him away—the dogs being too much astonished to make an attack I cannot resist giving another scene which was witnessed by this same naturalist an eagle seized a young Cercopithecus which by clinging to a branch was not at once carried off it cried loudly for assistance upon which the other members of the troop with much uproar rushed to the rescue surrounded the eagle and pulled out so many feathers, that he no longer thought of his prey but only how to escape This eagle as Brehm remarks, assuredly would never again attack a single monkey of a troop [9]

It is certain that associated animals have a feeling of love for each other which is not felt by non social adult animals How far in most cases they actually sympathise in the pains and pleasures of others is more doubtful especially with respect to pleasures Mr Buxton however who had excellent means of observation states that his macaws which lived free in Norfolk took an extravagant interest in a pair with a nest and whenever the female left it she was surrounded by a troop screaming horrible acclamations in her honour It is

surround and stare intently on a dying or dead companion apparently however as Houzeau remarks they feel no pity That animals sometimes are far from feeling any sympathy is too certain for they will expel a wounded animal from the herd or gore or worry it to death This is almost the blackest fact in natural history unless indeed the explanation which has been suggested is true that their instinct or reason leads them to expel an injured companion lest beasts of prey including man should be tempted to follow the troop In this case their conduct is not much worse than that of the North American Indians who leave their feeble comrades to perish on the plain or the

[8] Mr R. Brown in *Proc Zoolog Soc* 1868 p 409
Brehm *Illustrirte Thierleben* B 1864 52, 79 For the case of the monkeys extracting th

the old male baboons attacking the dogs, see s. 79 and with respect to the eagle s 56

f e l M B lt b l f n what I l as se f th l b ts f th se k y tl t tl y t t th l l m gl l y k t g t thr to- g tl r *The* ... 18 ... 113
l nal nd M ga ne of Nat al H t y November 1868 p 382.

others.[a] B t I cannot see how th s w e l r rrr ted from mutu l mpath pains the fact that mpath is excited in an imm a rabl stro r d gree b a bel ed, than by an indiff rent pe son. Th m re si ht of su ring and pend ntl of lo would uf fice t call p in us d recollect ns and associations. Th xplanation ma b in th fact that, with all nimals, mpath is directed sol l t wards th m mbers f th sam com munity and th ref re t w rd kn wn, and les beh ed m mbers, b t n t to all

mies.

and th rs, no doubt feel mpath f th suf f ring of th ir wn oung, b t not f that of oth mal. W th mankind selfishness,

re arn pe

to oth rs and mpathy is m ch trength ed b hab t. In ho complex a manner this feeling m h originated as t of high importance t al those animals wh h aid and d f nd anoth t will ha been increased through natural selecti f those communi ties which included th gre te t numbe of th most mpath t m mbers w ld fl rish best, and rear th gre test numbe f off pring.

It is, how mpossib t decid in man cases h th certai social nstinct h been acquired thro h natural selection, are th indirect result of th nstincts and facult es, such as mpath reason, exper nce and a tend nc t mutatio or again, wh ther th y are simpl the result f lo co tin ed hab t. So remarkabl an n tinct as th placing senti nel t warn th communit of dange can hardl ha bee th indirect result of an of these faculties t must, th refore h e been rectl acquired. O th th hand, th hab t follo ed b t males of som social animals of def nding th communit and of ttacking th mies their pre in co cert, ma pe

Of th various in tin ts and hab ts, som ar m ch tron r than others that is, som th r g m re pl asure in th r performance and more distress in th ir pre ntion, than others o which is probabl quite as impo tant, th y are through nh ritance m re persist ntl f l lowed, w th t exciti g any pecial *feeling of* plea ure pain. W are oursel es consci us that some hab ts are m ch more difficult to cure chan than th rs. H nce a truggl may oft n be observed in animals between dif f rent instin ts, o between an nsti ct and som hab tu l di posit n as wh n d g rushes aft a h re is rebuked pauses, hesitates, pu sues again, o retu ns ashamed to his mast r as between th lo of a f mal d f r her ou p pp es d f her ma te —f sh may be seen to link w y to them, as f half ashamed of n t ccompan g h maste But th most curi us in tance known to m of one instin t g tti g the bett of anothe th migrat ry nstinct co qu rin the maternal in stinct. Th f rm is wond rfull stron a co fined bird will t th prope season be t h r breast against th wires f h ca until it is bare and blood It cause oung salm n to l p t of th fresh w t in which th y could co tin to xist, and thus unint ti nall to commit suicide E r n know how tro g th mat rnal instinct is, l adin r n timid bird t face great dan th h with he t ti n, and n pposit n t th instin t of self preser t n. N rth less, th migr tory in tinct is so powerful, that lat in th t mn wallows, h use martins, and swifts frequ ntly desert th ir t d oun l ving th m to per ish miserabl in th ir nests.[b]

[a] pers benef ed, or others in his stead, ma trak b mpa hy nd good offices returned, f d he sacrifice I f as ppears t be the case ym path tinctl n t nct, ts rcise ould g direct pleasure e same manner the rcise as bef re remarked, of almost every other instinct.

[b] *of G at Britain*, 18 , p. 5 imilar cases ha been observed in Canada b Mr. Adams *P p. Science Review* July 1 73, p. 283.

...nated as lions are always on the look-out for the individuals which wander from the herd

With respect to the impulse which leads certain animals to associate together and to aid one another in many ways we may infer that in most cases they are impelled by the same sense of satisfaction or pl... ...y ex... ...e ac... ...on as ... instinctive actions are checked We see this in innumerable instances and it is illustrated in a striking manner by the acquired instincts of our domesticated animals thus a young shepherd dog delights in driving and running round a flock of sheep but not in worrying them a young fox hound delights in hunting a fox whilst some other kinds of dogs as I have witnessed utterly disregard foxes What a strong feeling of inward satisfaction must impel a bird so full of activity to brood day after day over her eggs Migratory birds are quite miserable if stopped from migrating perhaps they enjoy starting on their long flight but it is hard to believe that the poor pinioned goose described by Audubon which started on foot at the proper time for its journey of probably more than a thousand miles co... felt

... ...owards special enemies No one I presume can analyse the sensations of pleasure or pain In many instances however it is probable that instincts are persistently followed from the mere force of inheritance without the stimulus of either pleasure or pain A young pointer when ... ...ae ...in ...it ...be ... act thus either from pleasure or pain Hence the common assumption that men must be impelled to every action by experiencing some pleasure or pain may be erroneous Although a habit may be blindly and implicitly followed independently of any pleasure or pain felt at the moment yet if it be forcibly and abruptly checked a vague sense of dissatisfaction is generally experienced

It has often been assumed that animals were in the first place rendered social and that they feel as a consequence uncomfortable when separated from each other and comfortable whilst together but it is a more probable view that these sensations were first developed in order that those animals which would profit by living in society should be induced to live together in the same manner as the sense of hunger and the pleasure of eating were no doubt first acquired in order to induce animals to eat The feeling of pleasure from society is probably an extension of the parental or filial affections since the social instinct seems to be developed by the young remaining for a long time with their parents and this extension may be attributed in part to habit but chiefly to natural selection With those animals which were benefited by living in close association, the individuals which took the greatest pleasure in society would best escape various dangers whilst those that cared least for their comrades and lived solitary would perish in greater numbers With respect to the origin of the parental and filial affections, which apparently lie at the base of the social instincts, we know not the steps by which they have been gained but we may infer that it has been to a large extent through natural selection So it has almost certainly been with the unusual and opposite feeling of hatred between the nearest relations as with the worker bees which kill their brother drones and with the queen bees which kill their daughter queens the desire to destroy their nearest relations having been in this case of service to the community Parental affection or some feeling which replaces it has been developed in certain animals extremely low in the scale for example in star fishes and spiders It is also occasionally present in a few members alone in a whole group of animals, as in the genus Forficula or earwigs

The all important emotion of sympathy is distinct from that of love A mother may passionately love her sleeping and passive infant but she can hardly at such time be said to feel sympathy for it The love of a man for his dog is distinct from sympathy and so is that of a dog for his master Adam Smith formerly argued as has Mr Bain recently that the basis of sympathy lies in our strong retentiveness of former states of pain o...

... painful even in idea We are thus impelled to relieve the sufferings of another in order that our own painful feelings may be at the same time relieved In like manner we are led to participate in the pleasures ...

h l questi n of th m al sense turns. Wl sh uld man feel th t he ght t bey ne nstinct d sire r th tl an anotl r Why is l b tt ly rerretf l if h has yi lded to a tro g sense of self preserv tion, and has n t risked his l fe to sa e th t f a f ll -cre ture Or hy does he regret h t l n food from l ng

It is e id t in th first place th t w th mankind th ti ti imp lse ha d ff e t d ree of tre gth a sa g w ll ri k l s w l f t sa th t f a m mbe f th same communit b t will be wl lly i diff rent abo t t an u g and tim d m th r ged by tl m t rnal nst t will w tl t m ment h sit ti n, run the gre t t d g f l e wn f t, b t t f a m re f ll w cre ture N th l ss many ci ilized ma t, r n boy h n befo e risked hi l fe f an th b t f ll of co ge an l p tl y has disregarded tl e nsti t f self prese t n, and plun ed t e t a t rrent t sa

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I am are tl t som p rsons mai t in th t act pe f rmed imp l l as in th bo cases, d not com ud th d m m f tl e ral sense d an t be lled m ral Th y co fi this t rm t acti d d l be t ly aft t rs pposi g d res, wh n pr pted b som lt d m t B t t p- pears scarc l po sibl to d w any l ar l l d t nct of tl ki d A far as xalted

so co cerned many in tances have

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one s, th r tl an betra tl com ... urely the r co d ct ougl t to be consid red as m r l. As far as d l b rati and the ct ry m tives are co cerned ar mals

f r tl good f otl rs, are not called m al M co an th g perf rmed very oft n by us, w ll t last be don w th ut d l ber ti n l sitati o an l an tl en hardly l di tin guisl ed from an in t t t urely no o e w ll p ret d tl t u l n act n ceases t be m ral O tl e contrary we all feel tl t an act

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tl req t q al t e re i n t H wl o f rced to rcom h f ar want f m patl bef re h cts, d serv s, h ve in e w l gh cred t tl an tl e man whose n te d posit n l ad him t a good act witl ut eff t As we ann t d t gu sl between mo- t es, w ank all act ns of certain class as ral f perf rmed b m ral b g A m al be is wh e pabl f compari g l s past and f t re t ti s, and of ap- pro g d sappr g of tl em We h n

m nk y face d g t rescu ts com rad tak c arg f a orpl an m nk y w d t all ts co d t n al. B t n the ase f man wl al car w th certai t be ra ked as m ral b g act f ce tai class are called m al, wh tl perf med d l b t ly aft truggl w tl pposing m ti s, m p la ly thro gh nsti t, r from tl ffects f l ly gained h b t

B t to ret rn t u m re mmed t b- ject. Altho h som t t re m re po f l than th s, d thus l ad t corre po d g act s, t t u t nable th t n man tl social nst ts (l d g th l f praise and f ar f blame) possess gre t r tre gtl

I refer h re t the d t cti bet ee hat has bee called *material* nd *formal* m ral ty I am glad find that Professor H le (*Crit q nd Ad- d ses* 1873, p. 287) takes th sam w this t ject as I do. M Leslie t ph remarks (*Essay f ee Th ki g nd Pla Spe k g* 1873 p. 83), "Tl metaphysical distincti bet ee material nd formal moral y is as irreleva t as the uch dis- ti ctions.

Ihas g e uch case m ly of thre I ta g m I d ns h preferred be g h t aft th ther t betray g th pla of th ir compa ns ar (*J rnal f Researche* 1845 p 103)

We can perceive that an instinctive impulse if it be in any way more beneficial to a species than some other or opposed instinct would be rendered the more potent of the two through natural selection for the individuals which had it most strongly developed would survive in larger numbers Whether this is the case with the migratory in comparison with the maternal instinct may be doubted The great persistence or steady action of the former at certain seasons of the year during the whole day may give it for a time paramount force

Man a social animal —Every one will admit that man is a social being We see this in his dislike of solitude and in his wish for society beyond that of his own family Solitary confinement is one of the severest punishments which can be inflicted Some authors suppose that man primevally lived in single families but at the present day though single families or only two or three together roam the solitudes of some savage lands they always as far as I can discover hold friendly relations with other families inhabiting the same district Such families occasionally meet in council and unite for their common defence It is no argument against savage man being a social animal that the tribes inhabiting adjacent districts are almost always at war with each other for the social instincts never extend to all the individuals of the same species Judging from the analogy of the majority of the Quadrumana it is probable that the early ape like progenitors of man were likewise social but this is not of much importance for us Although man as he now exists has few special instincts having lost any which his early progenitors may have possessed this is no reason why he should not have retained from an extremely remote period some degree of instinctive love and sympathy for his fellows We are indeed all conscious that we do possess such sympathetic feelings [23] but our consciousness does not tell us whether they are instinctive having originated long ago in the same manner as with the lower animals or whether they have been acquired by each of us during our early years As man is a social animal it is almost certain that he would inherit a tendency to be faithful to his comrades and obedient to the leader of his tribe for these qualities are common to most social animals.

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The social animals which stand at the bottom of the scale are guided almost exclusively and those which stand higher in the scale are largely guided by special instincts in the aid which they give to the members of the same community but they are likewise in part impelled by mutual love and sympathy assisted apparently by some amount of reason Although man as just remarked has no special instincts to tell him how to aid his fellow men he still has the impulse and with his improved intellectual faculties would naturally be much guided in this respect by reason and experience Instinctive sympathy would also cause him to value highly the approbation of his fellows for as Mr Bain has clearly shewn [24] the love of praise and the strong feeling of glory

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highest degree by the wishes approbation and blame of his fellow men as expressed by their gestures and language Thus the social instincts which must have been acquired by man in a very rude state and probably even by his early ape like progenitors still give the impulse to some of his best actions but his actions are in a higher degree determined by the expressed wishes and judgment of his fellow men and unfortunately very often by his own strong selfish desires But as love sympathy and self-command become strengthened by habit and as the power of reasoning becomes clearer so that man can value justly the judgments of his fellows he will feel himself impelled apart from any transitory pleasure or pain to certain lines of conduct He might then declare—not that any barbarian or uncultivated man could thus think—I am the supreme judge of my own conduct and in the words of Kant I will not in my own person violate the dignity of humanity

The more enduring Social Instincts conquer the less persistent Instincts —We have not however as yet considered the main point on which from our present point of view the

[23] Hume remarks (*An Enquiry Concerning the Principles of Morals* ed. of 1751 p 132) There

[24] *Mental and Moral Science* 1868 p 254

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be apt to f llow the tro g mp lse and
tho gh this may occas nally prompt him to
t dood t will m re comm l lead

-e d ri g social instin t, and y m u p
regard f th good p m n f hi f ll ws, retri
b tion ll urel com H will th n feel re
m rse repe tance regret sham thi latt r
feeling, h we e rel t s alm t clu ly to
th j dgm t f tl rs. H will conseq ntly
resol m re l ss firmly to act diff rently f r
th f t re and thi consci ce f con
sci ce look backwards, and serv s as a guide
f th f t re

Th nat re and t gth f th feel gs
which w call regret, sh m repe tance r re-
m rse d pe d pp re tly n t ly o th
trength f th l ted nsti t, b t partl n
th stre gth of th t mptat and ft n till
m re th j dgm nt f f ll ws. H w far
ach man al es th pprec ti n f th rs, de
pend tl t gtl f hi te acq red
feeling f mp th and o hi wn capac ty
f reasoni g t th rem t co seq ce f
his acts. A th I m t m t mpo tant,
lth gh t necessary th re re ce f ar
f th Gods. Sp rit beli ed by ach man
and thi appli especiall ases f rem rse.

feel g f rem rse B t I can see littl f rce n
tl bject M rit d n t d fi wh t
th m an b rem rse and I can find n d fi
nit mpl g m re than an rwh lmi g
sense f repe tance It m rse seems t bear
th sam rel t t repe tance as ag doe
t g g t pain. It is far from
trang tl t an ti t so tro g and so g n
ally adm red as m t nal l sh ld if dis-
be ed l ad t th leepest misery as soon as
th mpress f tl past ca se f disobed
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posed t no pecial insti t, m rely to kn w
tl t fri nd and equals desp se us f t is
no l t use gre t m sery Wh can d bt
that tl ref sal t fight d l thro gh f ar
has sed man m an ag y f sham
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tl bott m f l so l b h g partak n f
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w man, to sat fy his nse f duty to his wi
I t ld h m that if h d d so I w uld se d h m
t prison f r life He remained about th farm
f r som m ths, b t g t e ceed gly thin, and
complained tl at he could n t est o e t, th t
his wife p rit was haunting him, because he
had n t tak n a lif f r h rs I was ine o able,
and assured l m th t n thing h uld save h m
if h did N rth l ss the man disappeared
f m re than year and th n returned n
h gh co dition and his the wif told D
Land th t h hu band had taken the life of
a w man b l gi g t d tant tribe b t it
was mposs bl t bta n l gal de ce of th
Th hre h f rul l ld sacred by th

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h rence (which th w qu t u al)

l w a nm wh ch th Au tralians h ld n
th gre t t abh rence in th agree ng e
actly w th certain trib f N rth Am rica.
Wh n th q t n is p t n th district,
t w rse to kill a gi l of a f gn trib to
marry girl f wn, an answ ju t ppo-
sit t rs w uld b gi n with t he t
t n.[2] W m y theref e, reject th b l f
l t l nsisted n by som writ rs, that th b-
h rre ce f ince t d e t possess g a
pec al God implanted consci ce On th
wh l t t llligibl th t a man urged by so
pow rf l sentim nt as rem rse th gh aris-

Insa ity Relatio to Law O tar o, United St tes, 1871 p 1

[2] E. B Tylor in C ntempor ry Review April, 1873 p. 07

have through long habit acquired greater strength than the instincts of elf i h

as followed the one natural impulse rather than the other and why does he further feel that he ought to regret his conduct Man in this respect differs profoundly from the lower animals Nevertheless we can I think see with some degree of clearness the reason of this difference

Man from the acti it acul ions ssing s mind Now with those animals which live permanently in a body the social instincts are ever present and persistent Such animals are always ready to utter the danger signal to defend the community and to give aid to their fellows in accordance with their habits they feel at all times without the stimulus of any special passion or desire some degree of love and sympathy for them they are unhappy if long separated from them and always happy to be again in their company So it is with ourselves

um sympathy a fundamental element of the social instincts A man who possessed no trace of such instincts would be an unnatural monster On the

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ieeling for instance of hunger nor indeed as has often been remarked of any suffering The instinct of elf

s u ts enemy face to face The wish for another man s property is perhaps a per sistent a desire as any that can be named but even in this case the satisfaction of actual possession is generally a weaker feeling than the desire many a thief if not an habitual one after success has wondered why he stole some article [27]

A man cannot prevent past impressions often repassing through his mind he will thus be driven to make a comparison between the impressions of past hunger vengeance satisfied or danger shunned at other men s cost with the almost ever present instinct of sympathy and with his early knowledge of what others consider as praiseworthy or blameable This knowledge cannot be banished from his mind and from instinctive sympathy is esteemed of great moment He will then feel as if he had been baulked in following a present instinct or habit and this with all animals causes dissatisfaction or even misery

The above case of the swallow affords an illustration though of a reversed nature of a temporary though for the per nct, At

t er season these birds seem all day long to be impressed with the desire to migrate their habits change they become restless, are noisy and congregate in flocks Whilst the mother bird is feeding or brooding over her nestlings the maternal instinct is probably stronger than the migratory but the instinct which is the more persistent gains the victory and at last at a moment when her young ones are not in sight she takes flight and deserts them When arrived at the end of her long journey and the migratory instinct has ceased to act what an im d t

con tantly passing through her mind of her young ones perishing in the bleak north from cold and hunger

At the moment of action man will no doubt

h n r t d b t d t b l g t th sam f m ly t b l n th f l g ld th u seem t be m t nd t ly t p t t e It t b t con pl nt le

t u se s, h led It s necessary th t th se t ts, t g th th sym pathy l ul h bee h lly cult ted t x t nded by th d f re so tru t t l l f f od bef re y u l g ld nrul ld e be th ght f a d obeyed

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sa a es tak h rri l pl a re n ru ity to animals,[34] and h manit a unkn wn rt e Ne rth l ss, be d th family affecti ns, kindness is comm n, e pecially d ri g ckn ss, bet ee th m mbers f th sam trib and

ne been highly steemed As no man can p act se th rt e ecessary fo the w lfare f his tribe witho t self sacrifice self-com mand and the pow r of endurance these qual ti h v be n at all time h ghly and m st j tly al ed Th Am ri ar savag ol nta rily s bm t t th m th rid t rtu es w thout a groan t pro and trengthen hi f rt tude and co rag ar d w ann t l lp admiring him r n an Indian Faki wl fro a fool sl rel gi m t ve w ngs su pended by a hook buried in hi flesh

Th oth r so-called self regarding virti es, which do n t b usly tho gh they ma really affect tl welfare f tle tribe l ne r been e teemed by savages, tho gh n w h hly ppreci ted by c vilised nat ons. The re test t temperance is o repro ch w th sa g s. Utte licent sn ss, and u n t ral rimes, pre ail t an ast un l g t t[35] As soo l w as m rriage, wh tl r polyg m us, m gam us, becomes comm n, j l ousy ll l ad to th incul at n f f male r t l tl s, bei g ho ured w ll t d to

t are bet ee th m mbers f th sam tribe thus Mungo Park h ard th n gro wom t aching thei y g hildren to l the truth Th s, again, is f th rt es wl ch b comes so deepl rooted in th mi d, th t t is som times p actised by sa ges, n t a l gh co t, l ard t ang b t to h to y ur my has rarely bee th ght as th h tory f mod rn dipl mac too plainly sh ws. A soo as tribe has recognised l d dis- bed ce becomes rim an l n abject bmissi looked t as sa red rt

As d ri g rud t m man an be useful faithful to h tribe w th t co rage, th q al t has uni rsall bee placed in th high est rank and alth gl ci lised countries good t t md man m be far m re usef l to th comm t than b e we cann t h lp in t nct ly h no ri g th latter abo co and ho be l t. Prud ce the th hand h h does t concern th w lfare of th rs, th gh ry sel l rt e has

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ings n tl walls f P mpe and by tl p ac t ce f man sa g s.

th t f the spec s, that f an d d al m mbe f tl trib Th ce l si g ee well w th the bel f tl t tl so-called m ral sense bo g ally d ri ed from tl social in t ts, f both relat t first e l ly t the comm nity

Th hi f se f the l w mo al ty of sa

[34] See M B g hot, *Phy ic nd Politics*, 18 2, p. 2.

[35] See, for stance M Hamilton acco t of the Kaffirs, *Anthropological Review* 18 0, p.

Mr M Le nan ha g (*P mitive M rri ge* 1865 p. 1 6) good coll cti f facts this head. Lecky *Histo y f E pe M ls*, ol. i., 1869 p. 1 9

Embassy to Ch a, vol. p 348.

last yield instantly and without a struggle to his social sympathies and instincts including his feeling for the judgment of his fellows The still hungry or the still revengeful man will not think of stealing food or of wreaking his vengeance It is possible or as we shall hereafter see even probable that the habit of self command may like other habits be inherited Thus at last man comes to feel through acquired and perhaps inherited habit that it is best for him to obey his more persistent impulses The imperious word *ought* seems merely to imply the consciousness of the existence of a rule of conduct however it may have originated Formerly it must have been often vehemently urged that an insulted gentleman *ought* to fight a duel We even say that a pointer *ought* to point and a retriever to retrieve game If they fail to do so they fail in their duty and act wrongly

If any desire or instinct leading to an action opposed to the good of others still appears when recalled to mind as strong as or stronger than the social instinct a man will feel no keen regret at having followed it but he will be conscious that if his conduct were known to

If he has no such sympathy and if his desires leading to bad actions are at the time strong and when recalled are not over mastered by the persistent social instincts and the judgment of others then he is essentially a bad man [30] and the sole restraining motive left is the fear of punishment and the conviction that in the long run it would be best for his own selfish interests to regard the good of others rather than his own

It is obvious that every one may with an easy conscience gratify his own desires if they do not interfere with his social instincts that is with the good of others but in order to be quite free from self reproach or at least of anxiety it is almost necessary for him to avoid the disapprobation whether reasonable or not of his fellow men Nor must he break through the fixed habits of his life especially if these are supported by reason for if he does he will assuredly feel dissatisfaction He must likewise avoid the reprobation of the one God or gods in whom according to his knowledge or superstition he may believe but in this case the additional fear of divine punishment often supervenes

The strictly Social Virtues at first alone regarded —The above view of the origin and nature of the moral sense which tells us what we ought to do and of the conscience which reproves us if we disobey it accords well with

rude men so that they may associate in a body are those which are still recognised as the most important But they are practised almost exclusively in relation to the men of the same tribe and their opposites are not regarded as crimes in relation to the men of other tribes. No tribe could hold together if murder robbery treachery &c were common consequently such crimes within the limits of the same tribe are branded with everlasting infamy [31] but excite no such sentiment beyond these limits A North American Indian is well pleased with himself and is honoured by others when he scalps a man of another tribe and a Dyak cuts off the head of an unoffending person and dries it as a trophy The murder of infants has prevailed on the largest scale throughout the world [32] and has met with no reproach but infanticide especially of females, has been thought to be good for the tribe or at least not injurious Suicide during former times was not generally considered as a crime [33] but rather from the courage displayed as an honourable act and it is still practised by some semi civilised and savage nations without reproach for it does not obviously concern others of the tribe It has been recorded that an Indian Thug conscientiously regretted that he had not robbed and strangled as many trav

Lecky *H t y f E ope n Mo l* L 1869 p 223 With re p ct t s g s M W n l

la d see *Th I y g f th* N ra l f r the M t i I la ds, Mull q t d by H uze u, *Le F c lt M nt le &c* t m. u p 136

hav been ntirely d t t t f consci ce.

tog th r with symp thy (wh ch l ad t our regarding th pprob t n and disapprobation f thers) ha ing se ed as th primary m pulse and guide Th tle proach m ed of la ing th f und ti f th n ble t p rt of ture in th base pri ciple f selfishn ss unl ss, ndeed th satisfacti n wh ch ry animal feels, wl t f ll w ts proper insti ts, and th d ssatisfacti n felt wh n pre nted be called selfish.

Th wish s and p ni ns f the m mb rs f th sam comm nity xpressed at first o ally b t lat by writi g also th f m th sole r les f r co d t gre tly re f rce the

tru m rality has ca sed many a man m re g y than real rim W recogni the sam infl ce in th b rning sense f hame l m t f u h f lt, aft th i t rval f y ars, h calli g t mi d som ac-

from gn ance and w ak po rs f asoni g H ce th t ang t t m and pe t t s,

h f lt by Hi doo wl breaks l ast and man th ch ase It w ld b d f fi lt t dist gu sl bet ce th rem rse f lt b Hindoo wl h y lded t th t mpt t n of t g un l food from th t f lt aft comm tti g th ft b t th f rm w ld prob bl be th more se re

H w so many absurd rules f co d t, as w ll as so man ab rd rel gi bel fs, h g ted w d t kn w l w t th t th l becom n all parts f th w ld leep l mpressed th mind f m n b t t rtl y from k tl t bch f constantly lcated d ri g th arl y ars f lif whilst th l ain mp s bl ppears to acq re al t th t re f an t t and th ry w ce f an nst t th t t f ll ed d pend tly f aso N th n say why ce tai admirabl t es, such as tl l f truth, are m ch m re h ghly pprec ted by

ir b — t ms and s perstit ns f

as t be th ught nn t alth ugh they w re l ad l m n n h arly co d ti n

plying lf sacrifice h rdl d serve to be called l w relat chi fly to self and arise from p b- l m tured by xpe i ce and c lti

th ch pe so ally unknown to him Th po t

unf rtun t l h w us h w l ng t is, before w look t th m as f ll -cre t r s. S m pathy b y nd the confine f man th t i hu

t ns. Th rv id f humanity as f r as I co ld bse was n w t m t f th G u h of tl I ampas. Th n tu f the nobl t with wl ch man i nd wed se ms to ar se m d tally from ymp th e becoming m re t d d m re w d l d ffused u t l th y are t ded to all se ti nt be gs. A soo as th rt l red and p act ed by some f w m n t p ad thro gh tru t n and x ampl t th y ung and t ally becom s corporated publ pini n

Th h l t possibl t n m al lture wh w recognise that w o ght to control

"Good nsta ces are g by M W llace in *Scient fic Op ion*, Sept. 15 1869 d m re fully n his *C t butions to th The ry f Nat al Selection*, 18 0 p. 353.

ages as judged by our standard are firstly the confinement of sympathy to the same tribe Secondly powers of reasoning insufficient to recognise the bearing of many virtues especially of the self regarding virtues on the general welfare of the tribe Savages for instance fail to trace the multiplied evils consequent on a want of temperance chastity &c And thirdly weak power of self-command for this power has not been strengthened through long continued perhaps inherited habit instruction and religion

I have entered into the above details on the immorality of savages [9] because some authors have recently taken a high view of their moral nature or have attributed most of their crimes to mistaken benevolence [40] These authors appear to rest their conclusion on savages possessing those virtues which are serviceable or even necessary for the existence of the family and of the tribe —qualities which they undoubtedly do possess and often in a high degree

Concluding Remarks —It was assumed formerly by philosophers of the derivative school of morals that the foundation of morality lay in a form of Selfishness but more recently the Greatest happiness principle has been brought prominently forward It is however more correct to spe k of t ple as con orks vrite

as if there must be a distinct motive for every action and that this must be associated with some pleasure or di pleasure But man seems often to act impulsively that is from instinct or long habit without any consciou ness of pleasure in the same manner as does prol ably a bee or ant when it blin lly follows its instincts Under circumstances of extreme peril as during a fire when a man endeavours to save a fellow creature without a moment she i tation he can hardly feel pleasure and still less has he time to reflect on the lissatisfaction which he *might* subsequently experience if he did not make the attempt Should he afterwards reflect over his own conduct he would feel that there lies within him an impul ive power widely different from a search after pleasure or happiness and this seems to be the deeply planted social instinct

In the case of the lower animals it seems much more appropriate to peak of their social instincts as having been developed for the general good rather than for the general happi ness of the pecies The term general good may be defined as the rearing of the greatest number of individuals in f ll

both of man and the lower ani mals l ave no doul t been developed by nearly the same step it woul l be advisal le if foun l practicable to use the same lefiniti n in both ca es and to take as the stan lar l of morality the general good or welfare of the community rather than the

en a man risks his lif to ave that of a fellow creature it s em also more corr ct to say that he acts for t

t at an early p ri d in th l i tory f man the expr l vi h of the community vill l ave naturally influenced to a la g xtent the con luct of ac l meml er and as all l for happiness the gre t

respect to t l l tt r tl eory th tandard nd the m t f co d t ha d bt ft n bee confused but th y are really n som d gree bl nded.

r Greatest h ppiness theory W th

[39] S e o i th ubj t cop us e d nce n chap vi of Si J Lubbock *O igin of C vil t on* 15 0

[40] For in tance Le ky *Hi t y f E pean Mo ls* vol i p 124

[41] Tl is t rm i used in an able rt cle in tl *W e t m n t Review* Oct 1869 p 498 F the Gr t t h ppiness pr nciple see J S M ll *U t l t r m* p 448

[42] M ll recogn s (*Sy t m f Log* vol. i p 422) in the cl re t m n i r tl t t m y b p f m d thro gh h b t tl t tl t p t i f pl ur M H S k k l n h l y n pl asure d D re (*Th C*

r desires. Thus, as M Galton* has remarked is all th l ss rprisi g as man has me ged from tat of barbari m w tl co p ti l recent period Aft r h g y lded to som t mptat we feel sense of dissat fac tion, l m repe tance rem rse anal go s to tl feelin caused by th r po rf l in t ts des res, wh n left unsat fied or I It I W compare th w ak ned impres-

n, and
If n Looki g t f t re g ti ns, th re set f ar that th soc al ti ts ll gro w k and we m y xpect th t tuo hab ts w ll grow tro g r becoming per h j fixed by nh ritance I thi case tl trug gle bet e hi h and lo e mp lse will be l ss se re, and rt e w ll be triumphant

S mm ry f the last tw Cl pler —Th re *an be no* d bt th t th d fference between the mind f th l west man and th t f th high est animal imm nse An anthr pom ph pe if h co ld tak d pass t w of his n case uld adm t th t th gh h could f m an artf l plan t pl d gar d —th gl h co ld se t f fighting f bre king pe ts, y t th t the th ght of fashi ning to to a tool was quit be- nd his scope Still less, as h w ld admit, co ld l f llow t train f m t physical reasoning sol m th matical probl m, reflect God admire grand t ral scene Som pes, I w w ld probably declare that th y co ld and did admire the be ty f th colo red hi and f f tl r partn rs in marri Th y w ld admit, that tho gl they co ld mak th pe d rstand l em som of tl percept ns and impl ants, th ti f y ress gd fin t id as by d fi t sound had rossed th m nds. Tl might insist that they w re read t ai l thei f llow-apes of tl sam troup man

w ys, t n k th r li es for th m and to take charge of th i rphans but tl ey w uld be f rced to acknowledg th t disinterested lo e f r all li g cre t res, the most n ble attrib t of man was qu t be d the compreh nsio

Ne e tl l ss the diff re ce n mind between man a d th h gh r animals, great as t s, cer tainly s o e of d gree and ot f ki d We have seen that the sense a d int t s, th various em ti s and fac lt es, ch as lo e m m ry att tio no ty mitat o reason, &c. f which man boasts, may be f und an cip nt, r e n som tim s in a w ll-d l ped co l t n th l animals. They are

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cert l l m ntal pow s, l as th f rm
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ves lt f otl r highly ad anced ntellectual

grad al l ti n. Th nn bling beli f G d i n t uni ersal w th man and the b l f in piritual ag ci naturally f ll ws from other m tal po rs. Tl m ral sense perh p af f rd th be t and high t distin t n b tween man and th l w an mals b t I need say nothi g this h ad, as I ha e so lat ly n de ured to sh w th t th social nst ncts — th prim pri ciple f man s m ral const t ti [50]—w th the aid f act e nt llect l po and th ffects f hab t, n turally l ad to the g ld n rule "As y w ld that m n sh ld d t y u d y t tl m l k w se nd thus h t th f d ti n f m rality

In th n t chapt I shall mak som few rem ks n th probabl t ps and m an by wh h th se ral m ntal and m al fac lti s f man h been grad lly l ed Th t ch l t t l ast possibl ght n t to be d nied f w daily see th se facult es d elop- ing n ry infant and w m y trace pe fect grad ti n from th mind f an utt d t, low than tl t f n animal l w in th scale t the mind f a Ne ton.

* See his rema kable ork *Hereditary Gen us*, 1869, p. 349 The Duke of Argyll (*Primeval M n*, 1869 p. 188) has some good remarks the co test ma nature bet e ght and ro g.

[50] Marcus Aurelius, *Meditations* Bk. V sect. 55

our thoughts and not even in inmost thought to think again the sins that made the past so pleasant to us "Whatever makes any bad action familiar to the mind renders its performance by so much the easier As Marcus Aurelius long ago said Such as are thy habitual thoughts such also will be the character of thy mind for the soul is dyed by the thoughts [5]

Our great philosopher Herbert Spencer has recently explained his views on the moral sense He says I believe that the experiences of utility organised and consolidated through all past generations of the human race have been producing corresponding modifications which by continued transmission and accumulation have become in us certain faculties of moral in

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There is not the least inherent improbability as it seems to me in virtuous tendencies being more or less strongly inherited for not to mention the various dispositions and habits transmitted by many of our domestic animals to their offspring I have heard of authentic cases in which a desire to steal and a tendency to lie appeared to run in families of the upper ranks and as stealing is a rare crime in the wealthy classes we can hardly account by accidental coincidence for the tendency occurring in two or three members of the same family If bad tendencies are transmitted it is probable that good ones are likewise transmitted That the state of the body by affecting the brain has great influence on the moral tendencies is known to most of those who have suffered from *chronic derangements of the digestion or liver* The same fact is likewise shewn by the perversion or destruction of the moral sense being often one of the earliest symptoms of mental derangement and insanity is notoriously often inherited Except through the principle of the transmission of moral tendencies we cannot understand the differences believed to exist in this respect between the various races of mankind

Even the partial transmission of virtuous tendencies would be an immense assistance to the primary impulse derived directly and indirectly from the social instincts Admitting for a moment that virtuous tendencies are inherited it appears probable, at least in such cases as chastity temperance humanity to animals, &c that they become first impressed on the mental organization through habit instruction

possessing such virtues having succeeded best in the struggle for life My chief source of doubt with respect to any such inheritance is that senseless customs superstitions and tastes such as the horror of a Hindoo for unclean food ought on the same principle to be transmitted I have not met with any evidence in support of the transmission of superstitious customs or senseless habits although in itself it is perhaps not less probable than that animals should acquire inherited tastes for certain kinds of food or fear of certain foes

Finally the social instincts which no doubt were acquired by man as by the lower animals for the good of the community will from the first have given to him some wish to aid his

more remote consequences of his actions as he acquired sufficient knowledge to reject baneful customs and superstitions as he regarded more and more not only the welfare but the happiness of his fellow men as from habit following on beneficial experience instruction and example his sympathies became more tender and widely diffused extending to men of all races to the imbecile maimed and other useless members of society and finally to the lower animals, —so would the standard of his morality rise higher and higher And it is admitted by moralists of the derivative school and by some intuitionists that the standard of morality has risen since an early period in the history of man [8]

As a struggle may sometimes be seen going on between the various instincts of the lower animal it is not surprising that there should be a struggle in man between his social instincts with their derived virtues, and his lower though momentarily stronger impulses

T n ys n *Idyll f the K g* p 44
[5] Marcus A l *Med tat o* Bk V s t 16
[6] Lett to Mr Mill n B i s *M nt l d M al Scienc* 1868 p 722
[7] Maudsl y *Bod nd M nd* 18 0 p 60

in man b t n th r m abilit n kn wled permits the tt mpt.

It deserves n tice that, as soo as th pro-g nit rs f man becam social (and this prob-abl occurred t e earl period) th prin cip f mitat n, and reason, and expe ce uld h i creased and m ch modified th tellectual pow rs w f which w see onl traces in th l w animals. Apes are much gi t m tati n, as are th l west sa ages and th mpl fact pre usly ref rred to, that afte tim n animal can be ca ght in th sam place by th sam sort f trap shew that animals learn by experie ce and imitat th ca ti of oth rs. Now if som n i nbe m re sa aci us than th th rs,

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lik se in som light degree tre gth the t llect. If th w t w re an mpo tant e, th tribe w ld crease in numbe pread and supplant th tribes. In tribe thus rendered m re n m rous there w uld al be rath gre t chance f th b rth of ther s pen and m ti m mbers. If su h m left hildren t inh rit th m tal superiont th hance f th b rth f till m re inrem us m mbers w ld be som what bett and rs small tribe decidedly bet t E en if th y left children, th tribe would till nclud their blood relati ns and t has bee ascertai ed by agriculturists[4] that by preservin and breedin from th famil f an animal, hich wh n la ght red was f und to be aluabl th desired charact has been obtai ed

T rning now t th social and m ral facul

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feeli gs, which impel th animals t li bod and th no d bt exh b ted th sam g neral d posit n. Th w ld ha f lt un-e se separated from th ir comrad s, f t m they w ld h f lt som d gree f lo th would ha warned ach th f dan er and ha g en m tual aid ttack d f nce All this impl es som d gree of sym path fid lity and courage Such social q ali-

ties, th param nt mportance of which to the l w animals d sputed by n n w re no do bt acq red by the prog nito s of man in a similar mann nam ly thro gh natural selecti n aided b nh rited hab t. When two tribe f prim al man, li n the same countr cam into competit n, if (th ci cumstance be ng equal) the on tribe ncl ded a gre t n mber of cour geous, mpath t c and f t l m mbers, who w re alw s ready to wa

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all important n th n r-ceas wars of sav es, fid lity and courag must be The ad an tage which disciplined soldi rs ha e r un disciph ed h rde foll w lu fl from th con fid ce which ach man feels in his comrades. Obed ce as M B g h t has w ll shewn, is f th l t al f any form f go rn

th abo q

tion us o th tribes but n th course of tim t w uld, j dgin from all past hi tory be in ts turn rcome b som the tribe still m re highl nd wed Th th social and m al q alities w uld t nd l wly t ad ance and be diffused thro gh ut th w ld

B t t m y be asked h w w thin th limits f th sam tribe did a larg numbe f m m bers first becom dowed with th se social and m ral qualiti s, and h w was th tandard f ell ce raised It xtrem ly d ubtful wh th th f prin f th m re mpath t and ben lent pare ts, f those wh w re th most faithf l to thei com ad s, would be reared n gre t numbers than th childre of selfish and treach ro parents belo gi g to th sam tribe. H who was read to sacrifice hi lif as many sa has been, rath than betra his comrad s, w ld ft n l a no ff spring t nh rit his nobl nature Th b e t m n, wh w re alw s w lli g to com to th fro t in war and wh freely risked th l es f th rs, w uld n an rage peri h in larg numbers than th m n. Th ref re t hardl seems probabl that th n mbe f m gifted with uch irtues, that th tandard f th ir cell ce, could be increased thro gh nat ral selecti n, that is, by th

[4] I ha gi en instances in my V riation of A imals under Domestication, ol. ii., p. 196.

[5] See remarkable series of articles Physics and Politics, in th Fort ly Review N 1867 April 1, 1868 July 1 1869 since separately published.

CHAPTER V

ON THE DEVELOI MENT OF THE INILLLECTUAL AND MORAL FACULTIES DURING I RIMEVAL AND CIVILISED TIMES

The subjects to be discussed in this chapter are of the highest interest but are treated by me in an imperfect and fragmentary manner Mr Wallace in an admirable paper before referred to [1] argues that man after he had partially acquired those ' al r o

means For man is enabled through his mental faculties to keep with in unchan

and various stratagems to procure food and to defend himself When he migrates into a colder climate he uses clothes builds sheds and m

n at a remote period he practised some division of labour

The lower animals on the other hand must have their bodily structure modified in order to survive under greatly changed conditions They must be rendered stronger or acquire more effective teeth or claws for defence against new enemies or they must be reduced in size so as to escape detection and danger When they migrate into a colder climate they must become clothed with thicker fur or have their constitutions altered If they fail to be thus modified they will cease to exist

The case however is widely different as Mr Wallace has with justice insisted in relation to the intellectual and moral faculties of man These faculties are variable and we have every reason to believe that the variations tend to be inherited Therefore if they were formerly of high importance to primeval man and to his ape like progenitors they would have been perfected or advanced through natural selection Of the high importance of the intellectual faculties there can be no doubt for man mainly owes to them his predominant position in the world We can see that in the rudest state of society the individuals who were the most sagacious who invented and used the best weapons or traps and who were best able to defend them

ould increase in number and supplant other tribes Numbers depend primarily on the means of subsistence and this depends partly on the physical nature of the country but in a much higher degree on the arts which are there practised As a tribe increases and is victorious it is often still further increased by the absorption of other tribes [2] The stature and strength of the men of

can be obtained In Europe the men of the Bronze period were supplanted by a race more powerful and judging from their sword handles with larger hands [3] but their success was probably still more due to their superiority in the arts

All that we know about savages or may infer from their traditions and from old monuments the history of which is quite forgotten by the present inhabitants shew that from the remotest times succe

in regions of the earth on the wild plains of America and on the isolated islands in the Pacific Ocean At the present day civilised nations are everywhere supplanting barbarous nations excepting where the climate opposes a deadly barrier

perfected through natural selection and this conclusion is sufficient for our purpose Undoubtedly it would be interesting to trace the development of each separate faculty from the state in which it exists in the lower animals to that in which it exists

[1] *Anthropological Review* May 1864 p clxx

[2] After a time the members of tribes which are absorbed into ... ... (... *Law* 1861 p 131) ... the ... descendants of the same ... M ... *Soc* ... *Nat* 1860 p 294

do eu m ... –
and increase.

It s, h w r y difficult to f rm any j dgm t why o e p rt cul tribe and not anoth has been successf l and has r sen in tl e scal f ci l ti n Many sa ges ar in tl sam cond ti n as wh n fi t d sco e ed se l ce t ri s g A M B g h t l as re- r k l n re nt t look t tl progr ss as

H nry Mai e in gre ... l as n h parti le of desire tl t ts ci l nstit t s l ld b mpro ed I ro ess se ms to d pe d many co u t fa rabl co d t ns far too compl x to b fol l ed t. B t t has ft be m ked th t a cool l m t f m l ading t i dustry and t tl ar s rt l as b h ghly f u abl tl ret Ft E i m pressed by h rd cessity h ceeded many g m us t ns, b t tl cl m t has been too se- re f co t ed prog N mad h b ts, l th w d plains, tl ro h th d ns f ests f tl trop cs l g tl h re f the sea, h e case bee l ghly d trime tal Wh lst bserv the barb ro uh b tants f T d l F g t truck th t th

of tl gro d and th f rst t ps c lti ti ld probabl lt, as I h lse h re l from som h acc d t as th seed f fru t tree f ll g h p f refuse and produc an ally fi an ty Th prob- l m, l f tl first ad ance f sa ges l l ci l sat t prese t m l too d ff lt to be sol ed

Nat al S lectio as ff ct g C rilised Na- t —I l l th rto nly co d ed th ad c t f m from human co d t t th t f tl mod rn sa ag B t som m k tl act f nat al selecti n l sed nat ns may be w rtl add g Tl l ject has bee ably d scussed by M W R.

Gr nd p iou ly by M W ll ce and Mr Galt n Mo t f my r marks are taken from th e tl ree th rs W th sa ag s, the w ak in body r mind are soon el min ted and those th t r i e commo ly e h b t a gorou s h lth W ci l ed me on the other l

t sa m m nt Tl s r ason to bel e th t acci t l p rved tl nds, wl o f om

m ... highly juri u t tl e ace of m n. It s p g h w soon a want f care r re w ly d ected l ads t the d g r ti n of

h lpl ss mai ly an cid ntal re ult f tl e st ct f symp thy wh ch was ori nally a quired as part f th soc al ti ts but s b c q tly rend ed in the mann r p i usly d cated m r ten l and mo wid ly d f fused N co ld we check ur symp tl y e n at th u gin f l ard ason, w tl t d teri a- t tl bl t part f tu e Tl e su geon m y h rd n h mself wl l t perform g an

u g and p pag t g th k nd but th e pp rs to be t l ast check n t dy act namely th t the weak and nf r

Ancient Law 1861 p. 22. F M B g hot remarks, *Fort ghtly Review* April 1 1868, p 4 2.

The V riation of A imal nd Pl nts nder Do- mestication, vl i., p 309

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survival of the fittest for we are not here speaking of one tribe being victorious over another

Although the circumstances leading to an increase in the number of those thus endowed within the same tribe are too complex to be clearly followed out we can trace some of the probable steps In the first place as the reasoning powers and foresight of the members became improved each man would soon learn that if he aided his fellow men he would commonly receive aid in return From this low

of sympathy which gives the first impulse to benevolent actions Habits moreover followed during many generations probably tend to be inherited

But another and much more powerful stimulus to the development of the social virtues is afforded by the praise and the blame of our fellow men To the instinct of sympathy as we have already seen it is primarily due that we habitually bestow both praises and blame on others whilst we love the former and dread the latter when applied to our selves and this instinct no doubt was originally acquired like all the other social instincts through natural selection At how early a period the progenitors of man in the course of their development became capable of feeling and being impelled by the praise or blame of their fellow creatures we cannot of course say But it appears that even dogs appreciate encouragement praise and blame The rudest savages feel the sentiment of glory as they clearly show by preserving the trophies of their prowess by their habit of excessive boasting and even by the extreme care which they take of their personal appearance and decorations for unless they regarded the opinion of their comrades such habits would be senseless

They certainly feel shame at the breach of some of their lesser rules and apparently remorse as shewn by the case of the Australian who grew thin and could not rest from having delayed to murder some other woman so as to propitiate his dead wife s spirit Though I have not met with any other recorded case it is scarcely credible that a savage who will sacrifice his life rather than betray his tribe or one who will deliver himself up as a prisoner rather than break his parole [6] would not feel remorse in his inmost soul if he had failed in a duty which he held sacred

We may therefore conclude that primeval man at a very remote period was influenced by the praise and blame of his fellows. It is obvious that the members of the same tribe would approve of conduct which appeared to them to be for the general good and would reprobate that which appeared evil To do good unto others—to do unto others as ye would they should do unto you—is the foundation stone of morality It is, therefore hardly possible to exaggerate the importance during rude times of the love of praise and the dread of blame A man who was not impelled by any deep instinctive feeling to sacrifice his life for the good of others yet was roused to such actions by a sense of glory would by his example excite the same wish for glory in other men, and would strengthen by exercise the noble feeling of admiration He might thus do far more good to his tribe than by begetting offspring with a tendency to inherit his own high character

With increased experience and reason man perceives the more remote consequences of his actions and the self regarding virtues such as temperance chastity &c. which during early times are as we have before seen utterly disregarded come to be highly esteemed or even held sacred I need not however repeat what I have said on this head in the fourth chapter Ultimately our moral sense or conscience becomes a highly complex sentiment—originating in the social instincts largely guided by the approbation of our fellow men ruled by reason self interest and in later times by deep religious feeling and confirmed by instruction and habit

yet that an increase in the number of well endowed men and an advancement in the standard of morality will certainly give an immense advantage to one tribe over another A tribe including many members who from possessing in a high degree the spirit of patriotism fidelity obedience courage and sympathy were always ready to aid one another and to sacrifice themselves for the common good would be victorious over most other tribes and this would be natural selection At all times throughout the world tribes have supplanted other tribes and as morality is one

[6] Mr Wallace gives cases in his *Contributions to the Theory of Natural Selection*, 1870 p 354

and increase.

It is, h w r ry difficult to f rm any j d m t why o e p ticular tr be and n t anoth has been successf l and has rise n tl scal of ci ilisati n Many sav ges are tl sam co d t as wh first d sco red se l ce t ries g ts M Bag h t has re- m ked w re pt t look at the progr ss as

H nry Mai e b
has sh w a part l f des re th t ts ci l nstit t ns l ld be mpro ed l ro ress seems to d pe d many con rent fa- rabl cond t s, far too comple to be f l l ed o t. B t t has ft n been remarked that cool l m t from lead g to dustry nd t tl n t l as b en l ghly f abl tl ret Tl e Esq m ux pressed by hard ecessit h ceeded many ing ni t ns, b t tl climate l as been too se- re f co t ed progr ss N mad hab ts, l th w d plains, thro gh th d ns f re ts f th trop cs, al g th h re f th sea, l case bee h gl ly d trim n tal. Wl lst bserv g th barb ro nhab tants f T rr d l F g t truck m th t tl

ld probabl re ult, as I h lsewh re l from som ch accid t as th seeds of fru t tree f ll ng h p f f se, and product an all fi an ty Th prob- lem l f tl first ad ance f sa ges t ard ci l sati t present m h too d ff cult to be sol ed

Nat al S lect as ff ct g C vilised Na- t ns —I l th rt nly cons d red th ad t f m from sem h man condi t t th t f th mod rn sa ag B t som remark th act f t ral selecti ci l sed nat ns m y be w rth add g Th b j t has bee ably d scussed by M W R. Gre a d pre sly by M Wallace and Mr G lto M t of my remarks are taken from th se three a th rs. With sa s, the w ak n body mind are soon limin ted and those th t comm nly xh b t a g rous f h lth We ci l ed m n, on the oth r l

l w and ur med cal m n ex rt tl r u m t skill t sa e tl lif of e ery on to tl e la t mon t Tl re reason to b l ve th t vacci n ti n has pr served tl sands, wl o from w k co t tuti n w ld fo m rly ha s c

p i g h w soon a want of care or are w ly l ected leads t the d g tion of

qu red as part f th soc l inst ts, b t bse- que tly re dered m th mann r pre i u ly ind cated m t nd r and m re w d ly dif f sed N r co ld w check mp thy t th u gi g f h rd r ason, w th ut d teri a ti m th bl t part f o ture The s geo m h rd n himself wh lst perf rmi g an pe t n, f he kn w th t l e is act fo th good f h p t nt but f e w te ti nally t glect the w ak and h lpless t co ll ly b f a co ti g nt b n fit witl an o rwh lmi g p sent l W m t th ref b ar th und btedly bad ffects of th w ak rv ving and p p g t g th kind b t tl re ppears to b t l ast o e check in t ady act nam ly that the weak and nf ri r

Ancient La 1861 p. 22. For Mr Bag hot remarks, *Fort ghtly Review* April 1 1868, p. 4 2.

The V riation of A imals nd Pl nts nder Do- m stication, ol. i., p. 309

F aser M g zine Sept 1868, p 353 This art l seems t h truck m y perso s, d ha gi rise t t remark bl ssa d j d

M E. Ray La kest his *Compa t Lo gevity* 15 0 p 128. Sim la ex ppe red pre usly th *Aust alas* July 13 1867 I ha borro ed idea from sev al of these t rs.

F M W llace see *Anth pological Review* as bef re ted. Mr Galt *Macm la M g ne* A g 1865 p 318 also his great w k, *Hereditary Gen us* 1870.

members of society do not marry so freely as the sound and this check might be indefinitely increased by the weak in body or mind refraining from marriage though this is more to be hoped for than expected

In every country in which a large standing army is kept up the finest young men are taken by the conscription or are enlisted They are thus exposed to early death during war are often tempted into vice and are prevented from marrying during the prime of life On the other hand the shorter and feebler men with poor constitutions are left at home and consequently have a much better chance of marrying and propagating their kind[11]

Man accumulates property and bequeaths it to his children so that the children of the rich have an advantage over the poor in the race for success independently of bodily or mental superiority On the other hand the children of parents who are short lived and are therefore on an average deficient in health and vigour come into their property sooner than other children and will be likely to marry earlier and leave a larger number of offspring to inherit their inferior constitutions But the inheritance of property by itself is very far from an evil for without the accumulation of capital the arts could not progress and it is chiefly through their power that the civilised races have extended where ace of rate accu ation of wealth interfere with the process of selection When a poor man becomes moderately rich his children enter trades or professions in which there is struggle enough so that the able in body and mind succeed best The presence of a body of well instructed men who have not to labour for their daily bread is important to a degree which cannot be over estimated as all high intellectual work is carried on by them and on such work material progress of all kinds mainly depend not to mention other and high r oubt men ever a a some degree of elimination here occurs for we daily see rich men who happen to be fools or profligate squandering away their wealth

Primogeniture with entailed estates is a more direct evil though it may formerly have been a great advantage by the creation of a dominant class and any government is better than none Most eldest sons, though they may be weak in body or mind marry whilst the younger son however superior in these respects do not so generally marry Nor can worthless eldest sons with entailed estates squander their wealth But here, as elsewhere the relations of civilised life are so complex that some compe rvene natur a rati n t ore beautiful and charming women and these must generally be healthy in body and active in mind The evil consequences, such as they may be of the conti f r wealth and power and thus th effect by marrying heiresses But the daughters of parents who have produced single children are themselves as Mr Galton[12] has shewn apt to be sterile and thus noble families are continually cut off in the direct line and their wealth flows into some side channel but unfortunately this channel is not determined by superiority of any kind

Although civilisation thus checks in many ways the action of natural selection it apparently favours the better development of the body by means of good food and the freedom from be in ound ro ger savages They appear also to have equal powers of endurance as has been proved in many adventurous expeditions Even the great luxury of the rich can be but little detrimental for the expectation of life of our aristocracy at all ages and of both sexes, is very little inferior to that of healthy English lives in the lower classes

We will now look to the intellectual faculties If in each grade of society the members were divided into two equal bodies, the one including the intellectually superior and the other the inferior there can be little doubt that the former would succeed best in all occupations, and rear a greater number of children Even in the lowest walk of life skill and ab

[1] Prof H F k (*Ei fl s der N t rwis nschaft f das Recht* Jun 18 2) has some good remarks a this h ad and u the such po nts.

[11] *Her d t y G* 18 0 pp 132 140

[12] *Q atref g s, P d C Scient fiq s 1867* 68 p 659

see th fth nd sixth col mns compiled from good uth t s, in th tabl g n n M F H. *La kest C mparat Lo gevity* 18 0 p. 115

ty mu.t be of some ad anta th gh n many occupati ns, wing t th great d n of labo very small H ce n lised nati ns there w ll be som t nd to an in crease both in th numbe and in the sta dard of th int llect ally abl B t I do n t wish to assert th t thi t nd cy m y n t b more than counterbalanced n th w ys, as by the mult plicati f th reckl ss and mpro d t b t n to ch as th se bil ty must be so

f

ha n una —

their gre t int llect. Mr Galto says, I regret I am unable to sol the simple q ti n h th and h w far m n and w m n who are prod nes f geni s are inf rt le I h h w sh wn that m n f min ce are by n m ans so. [15] Great la g rs, th f nd rs f be fice t relig ns, gre t philosoph rs and disco rers n sci ce, and the pro ress f man kind far l gh d gree by th ir w ks than by l ng um ro s prog y In th

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di iduals, and t th prese ti n of tro gly m ked and rare an m l s, th t l ad t th ad ancem nt f a pec s. So t will be with tl t llectual facult s, since th som wh t abl m ach g d f soci ty ceeed th bett than th l ss ble, and conse q tl increase mbe f t th rw se pre ted Wh an nat tl t dard f tellect and th umbe f t llect al m h ncreased w may xpect from th l w f tl d t from an age, that prod g of g nius w ll as sh wn by Mr G lton, ppear som h t m re freq tly than bef re

I re ard to th m ral q aliti s, som limi nat f tl rst d sposit ns alw y pr res tl most civilised t ns. Mal fact rs are e ted impriso ed f lo g periods, so that th t freely t ansm t tl bad q al t es. Melan l l and in sa pers a confi ed commit uicid V l t al q rrelsom m oft com t bk l ol Th re tless l w ll t f llow an t al occupat —and tl rel f bar bari m is gre t l ck to ci l sati —emi g t to ne ly-settled co tries, wh re th y pro useful p ee s. Int mper nce s so l gh ly d tru ti e, th t the xpectat n of lif of the t mpe te t the ge of th rty fo i tance o ly 13 8 a s whilst f the u al labo re of England t th same g it i 40 9 y rs. [16] Proflig te w men bear f w childr n, and profl g t men rarely ma r l oth ff r from disease In th breed g f d m tic ani mals, th l min t n f those d d als, th gh f w n number wh ch are n any m ked manne inf ri s b no m ns an unimport t l m t t w rds uccess. Thi especially h lds good w th jurious charact s whi h t d to re ppear thro gl re rs n, h as blackn ss n sheep and with manki d m f th w r t d po t ns, which occa-

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w seems deed ecognised in th comm n express n th t ch men re th bl k sheep of th famil

W th c lised t s, as far as an ad anced standard f m rality and an in r ased number f fai ly good m n ar co cerned natural selecti n pparently ffects b t little th gh th f d m ntal social nsti cts w re riginally th s gained B t I ha alre d sa d gh,

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— xampl and m t t n—reaso — xperi ce and self int re t—instru t n duri g th, and rel g feelings.

A most mportant b tacl ci ilised coun tri to an in rease in th umb f m n f a peri class has bee tr gly ns ted n by Mr Greg and Mr G lt nam ly th fa t that th y poo and reckl ss, who are ften d graded by ce almo t in ari bly m rry arl whilst th areful and f gal who are g rall therwise art us, marry lat n lif so th t th y m y b abl to pport th m sel and th ir hildren n comf rt Th se wh marry arly prod ce w thin gi period n t al gre t numbe f g rati ns, b t,

Hereditary Gen us, 18 0 p. 330.
Origi of pec this ed ti n, p. 49.
Hereditary Gen us, 1 0 p. 347

E. Ray La kest *Compa at Lo gevity* 1870, p 115 Th tabl of th int mperat is from N iso *Vital Statistic* I regard to profl g cy see D F rr Influence of Marriag M rtality *Nat Assoc for th Promotio of Social Science* 1858
F aser M gazine Sept., 1868, p 353 *Macmilla M gazine* A g 1865 p 318. Th Rev F W F rra *F aser M gazine* A g 18 0, p. 264) takes differe t iew

as shewn by Dr Duncan [20] they produce many more children The children moreover that are borne by mothers during the prime of life are heavier and larger and therefore probably more vigorous than those born at other periods Thus the reckless degraded and often vicious members of society tend to increase at a quicker rate than the provident and generally virtuous members Or as Mr Greg puts the case The careless squalid unaspiring Irishman multiplies like rabbits the frugal foreseeing self respecting ambitious Scot stern in his morality spiritual in his faith sagacious and disciplined in his intelligence passes his best years in struggle and in celibacy marries late and leaves few behind him Given a land originally peopled by a thousand Saxons and a thousand Celts—and in a dozen generations five sixths of the population would be Celts but five sixths of the property of the power of the intellect would belong to the one sixth of Saxons that remained In the eternal struggle for existence it would be the inferior and *less* favoured race that had prevailed—and prevailed by virtue not of its good qualities but of its faults

There are however some checks to this downward tendency We have seen that the intemperate suffer from a high rate of mortality and the extremely profligate leave few offspring The poorest classes crowd into towns and it has been proved by Dr Stark from the statistics of ten years in Scotland [1] that at all ages the death rate is higher in towns than in rural districts and during the first five years of life the town death rate is almost exactly double that of the rural districts As these returns include both the rich and the poor no doubt more than twice the number of births would be requisite to keep up the number of the very poor inhabitants in the towns relatively to those in the country With women marriage at too early an age is highly injurious for it has been found in France that Twice as many wives under twenty die in the year as died out of the same number of the unmarried The mortality also of husbands under twenty is excessively high [22] but what the cause of this may be seems doubtful Lastly if the men who prudently delay marrying until they can bring up their families in comfort were to select, as they often do, women in the prime of life the rate of increase in the better class would be only slightly lessened

It was established from

[illegible] ion than the married for instance out of every 1000 unmarried men between the ages of twenty and thirt [illegible]

[illegible] in 1864 with the entire population above the age of twenty in Scotland for instance out of every 1000 unmarried men between the ages of twenty and thirty 14 9 annually died whilst of the married only [illegible] died that is less than half [1] Dr Stark remarks on this Bachelorhood is more destructive to life than the most unwholesome trades or than residence in an unwholesome house or district where there has never been the most distant attempt at sanitary improvement He considers that the lessened mortality is the direct result of marriage and the more regular domestic habits which attend that state He admits however that the intemperate profligate and criminal classes, whose duration of life is low do not commonly marry and it must likewise be admitted that men with a weak constitution ill health or any great infirmity in body or mind will often not wish to marry or will be rejected Dr Stark seems to have come to the conclusion that marriage in itself is a main cause of prolonged life from finding that aged married men still have a considerable advantage in this respect over the unmarried of the same advanced age but every one must have known instances of men who with weak health during youth did not marry and yet have survived to old age though remaining weak and therefore always

[20] On the [illegible] of the F[illegible] [illegible] *T[illegible] actions of the Roy[al] Soc[iety] Ed[in]burgh* [illegible] p 287 [illegible] published [illegible] the title *of Fecundity Fertility and Sterility* 1871 See al[so] Mr G[alton] *Hereditary Genius* pp 352-3 7 for observations [illegible] effect.

[21] *T[enth] An[nual] Report of B[irths] D[ea]th[s] [illegible] Scotland* 1867 p xi

[22] These quotations are taken from [illegible]

[illegible] D[r] [illegible] Oct 17 1868 [illegible]

[23] D[r] [illegible] The quotations [illegible] are [illegible] from the same [illegible] paper

[24] [illegible] the T[enth] [Annu]al Report of B[irths] D[ea]ths [illegible] Scotland 1867 [illegible] Dr St[ark] [illegible] Oct 17 1868 [illegible] carefully written

with a l sse ed chance f lif r of marryi g There is an th remarkabl cum tance hich seems to suppo t D Stark s conclus n nam ly that d ws and w d wers n Fran suff r in comparison with tl e m rried ry h ry rate f m rtal ty b t D Far t trib te this to th po rty a d l habits conseq t n the di rupti n f th family and t gri f O the wh l we m y concl de th Dr Farr th t tl e lesse m rtal ty f m rried than f unmarried m n, which seems t be g e all mainly d e to th con tant l minat n f mperfect t pes, and to the skilful selecti n of th fin t nd d als t f ach ccessi g e ti n the selec t relati lv t th ma riage tat and acting all corporeal t llect al, and m al q al t s.[23] W ma th ref re infe that so d and good m n wh t f pru d nce remain f a tim unmarried do n t suff h gh rat f m rtal ty

If the ari us checks pecified in the tw l t paragraphs, and pe h p tl rs as y t un

class of m n, th natio will retrograd as has too ft occurred in th l t ry f th wo ld. W must remembe that progress n ari abl rul It is ry d fficult to say why c i l sed nati n rises, becom mo pow rful, and spread m re w d ly than an th l th sam ti p gresse m re quickly t tim than t an tl W an ly say tl t t d pends an increase in the actual mbe f th pop l ti n, th mbe f m nd wed with high t llect al and m ral fac lties, as well as th tand rd f ccel lence C rporeal tru t re ppear to h e littl fl ce cept so f as g ur of body l ad to ou f m d

It has bee g d b se al writ rs th t as high t llect l pow are ad a tageo t t n, th ld Greeks, h tood som grad s h ghe t l ect than any race th t has xi ted [24] ght, f th po f nat al selec t re real, t h rise still higl the sc l ncreased mbe and stocked th l l of E rope H w ha th tacit as-sumption, so oft n made with re pect to cor poreal tru tures th t there i some i n te tend cy t wards continued de elopment in mind and body B t de elopme t of all kinds d pend on many co c rrent fa ou able cir cum tances. Natu al select on act only t nta ti ely I di duals and aces may ha e ac quired ce tain i di p tabl ad ant g s, and yet ha e perished f om fail g n ther char act s. The Greeks may have retrog aded from want of cohe e ce between the many small tat s, from the small size f th r wh le co ntry from th p a tice f la e y from extrem sensuality fo th y d d n t uccumb u t l th y were n r ted and corrupt to th v ry core [25] The western nati ns of E rope wh w so mmea ably surpass the former

w ks f th t w nd rful people

Wh can positi ly say why the Spani h na ti n, so d min t t e time, has be n dis tanced in the race Th aw kem g f the na tions f Europe from the dark ages s a till m re pe l xing problem At th t arly period as Mr Galt n has remarked alm t all the m n of ge tl n t re th se giv n to med ta ti n cult re f th mind had no ref ge e cept in the bosom f a Cl urch which de manded celibacy [26] and th could hardl fail to h had a d t ri rating nfl nce n ach success g n rati n Duri thi same period th H l I q i t n selected with e treme are th free t and bold t m n in ord to b rn r imprison them In Spain alo som of th b st m n—tl se wh d ubted and q es t ed and with ut d bting there can be no progress—w re limi ted d ring three cen t es at th t f a th sand year Th e l wh ch the C th l Church has thus ffected is incal labl th gh no d bt coun t balanced t a certain, perhaps to large t t the w s n erth less, Europe l as progressed t n paralleled t

Th remarkabl s ccess f the En lish as col ni ts, compared to th European na

[23] D D nca remarks (F cundity Fertility &c., 1 71 p 334) th subject At ev ry g the heal hy nd bea tiful go er from th nmarried side t the married, leavi g the married columns ded th the sickly nd nfortunat

[24] See the genious and original argume t this b ect by M Galton, Hereditary Genius, pp. 340-342.

tions has been ascribed to their daring and persistent energy a re ult which is well illustrated by comparing the progress of the Canadians of English and French extraction but who can say how the English gained their energy There is apparently much truth in the belief that the wonderful progre s of the United States as well as the character of the people are the results of natural selection for the more energetic restles and courageous men from all parts of Europe have emigrated during the last ten or twelve generations to that great country and have there succeeded best [29] Looking to the distant future I do not think that the Rev Mr Zincke takes an exaggerated view when he says [30] All other series of events—as that which resulted in the culture of mind in Greece and that which resulted in the empire of Rome—only appear to have purpose and value when viewed in connection with or rather as subsidiary to the great stream of Anglo-Saxon emigration to the west Obscure as is the problem of the advance of civilisation we can at least see that a nation which produced during a lengthened period the greatest number of highly intellectual energetic brave patriotic and benevolent men would generall vail over less

i the struggle
pid rate of increase It is impossible not to regret bitterly but whether wisely is another question the rate at which man tends to increa e for this leads in barbarous tribes to infanticide and many other evils and in civilised nations to abject poverty celibacy and to the late marriages of the prudent But as man uffers from the same physical evils as the lower animal he has no right to expect an immunity from the evils consequent on the struggle for existence Had he not been subjected during p i meval times to natural selection assuredly he would neve have attained to hi pre ent rank Since we see in many part of the world enormous areas of th most fertil f

ut at the struggle for ex tence had not been suffici ntly e r to f rce man upwards to his highest st n l rd J dging from all that we know of man and the lower animals there has always been sufficient variabil ity in their intellectual and moral faculti for a steady advance through natural selecti n No doubt such advance demands many favourable concurrent circumstances but it i ay well be doubted whether the most favourable would have sufficed had not the rate f increa e been rapid and the co co

that a people which may be called civilised such as the Spanish settlers, i liable to become indolent and to retrograde wh en the conditions of life are very easy With h hly civilised nations continued progress depends in a subordinate degree on natural electi n for such nations do not supplant and exterminate one another as do avage trib s Nevertheless the more intelligent members within the same community will succeed better in the long run than the inferior and leave a more num rous progeny and thus is a form of natural election The more efficient causes f n r

e t and be t men embodied in the laws customs and traditions of the nation and enforced by public pinion It should how ever be borne in min l th t

a i this appreciation i founded on ur sympathy which it can hardly be doubted was originally developed through natural election as one of the most important elements of the social instincts [a]

On the evidence that all civilised nations were once barbarous —The present ubject has been treated in o full and admirable a m n r by Sir J Lubbock [32] M Tylor Mr M Lenn an l oth r th at I need here give only the briefest summary of th ir results The arguments rec ntly advanced by the Duke f Argyll [33] and fo merly by Archbi hop Wh t ly in fa or of the b f that man cam int the w rld as a civil s d b ing and that all sa ages have nce und rg ne degradation seem t me weak in compari n with those ad an ed on

[29] Mr G lt n M cm ll n s M g A g t 186 p 3 See also Nat O D d N t on II f Dec. 1869 p 1
[30] *Last Winter in th Un t d St t* 1868 p 29

I h d bted t M J l i M l y f r g l t th ject see L Broca Le S lect s, l d' t ll g' Anthr 1872
[32] *O th O g n f C l s t* 1867
[33] *Primeval M n* 1869

latt h ad I ha m t with n evid nce. F gians w re probably compelled by th co q erin b rd to settl th inh p ta ble country and th m y h e becom in conseq ence som wh t m re d graded b t it ld be difficult t pro th t th y ha falle much bel w th Botocudos, who inhab t th fin st parts f Braz l.

Th id nce th t all ci ilised n ti ns are th descendants f barbarians, consists, n th one ide, of cl ar trace f th ir f rm l w cond ti still-exist g customs, beliefs, language, &c. and th th sid f proof that sa ges are i d pe dentl abl t raise th msel es f w t p th scal f ci ilisa tion, and ha act all thus risen. Th e d nce the first h ad trem l cur s, b t cannot be h re gi n I ref to ch cases as th t of th art of num rati n, which, as M Tyl clearl sh w b ref re ce t th word till used in som places, rigi ted in counting th fi g rs, first f hand and then of th th and la tl f th toes. We h traces f this m w decimal st m and in tl Roman num als, wh re, aft th V wh h is supposed to be an abbrev ted p cture of human hand w pass n to VI, &c., wh n the ther hand d bt was used So gain, When w peak f three score and t n, w are counting by th gesimal t m, ach score thus ideally mad tand g f 20—f man as M xican Carib w ld p t t.[34] According to lar and reasi g school of philologists, ry languag bears th marks of ts low and grad al l t n. So t with th art of writi g, f l tt rs are rudim ts of p torial representati ns. It is hardl possibl t read M M Lennan w k[35] and t admit that alm t all lised nat ns still retain trace of uch rud hab ts as th f rcibl cap t re of wi s. What ancient nat n, as th sam thor asks, can be named that was riginally m n gam us Th primiti e idea of j l wn l y th l w of battl and other beli fs. The highe t f rm of rel gi n—the grand d of God hating sin and l ving righteo sn ss—was unkn wn during prime al tim s.

T rni g t the the kind of evidence Sir J L bbock has shewn that som sa a s h recently mpro ed littl in som of th r simpl r arts. From the tremely curi us c count which h gi f the w apons, tools, and arts, in se am ng t sa age n ari u parts f th w ld t ca n t be doubted that th se have n arly all been i d pendent disco ri s, cept pe h ps th art f maki fire.[36] Th Au tralian boome an s good nstance f one such d pend nt disco ry The Tahit ans when fi t visited had ad anced n man re pects be nd th nh b tants of m t f the th P l nesian islands. Th re are n ju t ground f th beli f that th high cult re of th n ti P ruvians and M xicans was de ri ed from abroad;[37] many nat e plant w re th re cultiv ted, and f w n ti animals domest cated W sh uld bear in mi d that, judging from th small infl ce f m t mis si nari s, wand ring crew from som semi civilised land if washed t th sh res f Am ca, wo ld not h produced any marked ffect on the nati es, unless th y had already

nhab tants retai no trad t n Th re also i direct d ce f th f rm use by th Chi ese and anci t J ws. H ce th re can hardl be d bt th t th nhab tant of these co tri s, which includ arly th wh l ci lised w ld w re nce in a barbaro con

[34] Ro l Institution f Gr at Britain, March 15, 1867 Also R searches nto the Early History f ... the Class. s tem of Rela ionship, Proc Amer ... Acad of Science ol. ... 1868. Prof Schaaffha se Anth ropolog Review Oct., 1869 p. 373 rema ks ... the est ges f h ma sacrifices found both Homer nd the Old Testam t.

[36] Sir J Lubbock, Pr historic T mes 2 d ed., 1869 haps. ... od ... et passim See also th ex celle t 9th hapt Tylo Ea ly History f Man kind, 2 d ed., 18 0.

[37] D F Müller has mad som good remarks to this ffect th Reis der Nova Anthropolog Theil, Abtheil. iii., 1868, s. 127

dition To believe that man was aboriginally civilised and then suffered utter degradation in so many regions is to take a pitiably low view of human nature It is apparently a truer and more cheerful view that progress has been much more general than retrogression that man has risen though by slow and interrupted steps from a lowly condition to the highest standard as yet attained by him in knowledge morals and religion

CHAPTER VI

ON THE AFFINITIES AND GENEALOGY OF MAN

Even if it be granted that the difference between man and his nearest allies is as great in corporeal structure as some naturalists maintain, and although we must grant that the difference between them is immense in mental power, yet the facts given in the earlier chapters appear to declare, in the plainest manner, that man is descended from some lower form, notwithstanding that connecting links have not hitherto been discovered.

Man is liable to numerous, slight, and diversified variations, which are induced by the same general causes, are governed and transmitted in accordance with the same general laws, as in the lower animals. Man has multiplied so rapidly, that he has necessarily been exposed to struggle for existence, and consequently to natural selection. He has given rise to many races, some of which differ so much from each other, that they have often been ranked by naturalists as distinct species. His body is constructed on the same homological plan as that of other mammals. He passes through the same phases of embryological development. He retains many rudimentary and useless structures, which no doubt were once serviceable. Characters occasionally make their re-appearance in him, which we have reason to believe were possessed by his early progenitors. If the origin of man had been wholly different from that of all other animals, these various appearances would be mere empty deceptions; but such an admission is incredible. These appearances, on the other hand, are intelligible, at least to a large extent, if man is the co-descendant with other mammals of some unknown and lower form.

Some naturalists, from being deeply impressed with the mental and spiritual powers of man, have divided the whole organic world into three kingdoms, the Human, the Animal, and the Vegetable, thus giving to man a separate kingdom.[1] Spiritual powers cannot be compared or classed by the naturalist: but he may endeavour to shew, as I have done, that the mental faculties of man and the lower animals do not differ in kind, although immensely in degree. A difference in degree, however great, does not justify us in placing man in a distinct kingdom, as will perhaps be best illustrated by comparing the mental powers of two insects, namely, a coccus or scale-insect and an ant, which undoubtedly belong to the same class. The difference is here greater than, though of a somewhat different kind from, that between man and the highest mammal. The female coccus, whilst young, attaches itself by its proboscis to a plant; sucks the sap, but never moves again; is fertilised and lays eggs; and this is its whole history. On the other hand, to describe the habits and mental powers of worker-ants, would require, as Pierre Huber has shewn, a large volume; I may, however, briefly specify a few points. Ants certainly communicate information to each other, and several unite for the same work, or for games of play. They recognise their fellow-ants after months of absence, and feel sympathy for each other. They build great edifices, keep them clean, close the doors in the evening, and post sentries. They make roads as well as tunnels under rivers, and temporary bridges over them, by clinging together. They collect food for the community, and when an object, too large for entrance, is brought to the nest, they enlarge the door, and afterwards build it up again. They store up seeds, of which they prevent the germination, and which, if damp, are brought up to the surface to dry. They keep aphides and other insects as milch-cows. They go out to battle in regular bands, and freely sacrifice their lives for the common weal. They emigrate according to a preconcerted plan. They capture slaves. They move the eggs of their aphides, as well as their own eggs and cocoons, into warm parts of the nest, in order that they may be quickly hatched; and endless similar facts could be given.[2] On the whole, the difference in mental power between an ant and a coccus is immense; yet no one has ever

[1] Isidore Geoffroy St.-Hilaire gives a detailed account of the position assigned to man by various naturalists in their classifications: *Hist. Nat. Gén.* tom. ii., 1859, pp. 170-189.

[2] Some of the most interesting facts ever published on the habits of ants are given by Mr. Belt, in his *The Naturalist in Nicaragua*, 1874. See also Mr. Moggridge's admirable work, *Harvesting Ants, &c.*, 1873, also *L'Instinct chez les insectes*, by M. George Pouchet, *Revue des Deux Mondes*, Feb., 1870, p. 682.

dreamed of placing these insects in distinct classes much less in distinct kingdoms No doubt the difference is bridged over by other insects and this is not the case with man and the higher apes But we have every reason to believe that the breaks in the series are simply the results of many forms having become extinct

Professor Owen relying chiefly on the structure of the brain has divided the mammalian series into four sub classes One of these he devotes to man in another he places both the marsupials and the Monotremata so that he makes man as distinct from all other mammals as are these two latter groups conjoined This view has not been accepted as far as I am aware by any naturalist capable of forming an independent judgment and therefore need not here be further considered

We can understand why a classification founded on any single character or organ—even an organ so wonderfully complex and important as the brain—or on the high development of the mental faculties is almost sure to prove unsatisfactory This principle has indeed been tried with hymenopterous insects but when thus classed by their habits or instincts the arrangement proved thoroughly artificial [3] Classifications may of course be based on any character whatever as on size colour or the element inhabited but naturalists have long felt a profound conviction that there is a natural system This system it is now generally admitted must be as far as possible genealogical in arrangement —that is the co descendants of the same form must be *kept together in one group apart from the co-descendants of any* other form but if the parent forms are related so will be their descendants and the two groups together will form a larger group The amount of difference between the several groups—that is the amount of modification which each has undergone—is expressed by such terms as genera families orders and classes As we have no record of the lines of descent the pedigree can be discovered only by observing the degrees of resemblance between the beings which are to be classed For this object numerous points of resemblance are of much more importance than the amount of similarity or dissimilarity in a few points If two languages were found to resemble each other in a multitude of words and points of construction they would be universally recognised as having sprung from a common source notwithstanding that they differed greatly in some few words or points of construction *But with organic beings the* points of resemblance must not consist of adaptations to similar habits of life two animals may for instance have had their whole frames modified for living in the water and yet they will not be brought any nearer to each other in the natural system Hence we can see how it is that resemblances in several unimportant structures in useless and rudimentary organs or not now functionally active or in an embryological condition are by far the most serviceable for classification for they can hardly be due to adaptations within a late period and thus they reveal the old lines of descent or of true affinity

We can further see why a great amount of modification in some one character ought not to lead us to separate widely any two organisms A part which already differs much from the same part in other allied forms has already according to the theory of evolution varied much consequently it would (as long as the organism remained exposed to the same exciting conditions) be liable to further variations of the same kind and these if beneficial would be preserved and thus be continually augmented In many cases the continued development of a part for instance of the beak of a bird or of the teeth of a mammal would not aid the species in gaining its food or for any other object but with man we can see no definite limit to the continued development of the brain and mental faculties as far as advantage is concerned *Therefore in determining* the position of man in the natural or genealogical system the extreme development of his brain ought not to outweigh a multitude of resemblances in other less important or quite unimportant points

The greater number of naturalists who have taken into consideration the whole structure of man including his mental faculties have followed Blumenbach and Cuvier and have placed man in a separate Order under the title of the Bimana and therefore on an equality with the orders of the Quadrumana Carnivora &c Recently many of our best naturalists have recurred to the view first propounded by Linnæus so remarkable for his sagacity and have placed man in the same Order with the *Quadrumana under the title of the Primates* The justice of this conclusion will be admitted for in the first place we must bear

[3] Westwood *Modern Classification of Insects* vol. ii. 1840 p 87

in mind th comparati insignificance fo classificati of th gre t d el pm nt f th brain in man, and th t the tro gl marked d... rences between the ...kulls of man and th Quadrumana (latel insisted pon b Bisch ff Aeb and others) ppare tl f llow from th ir d... rently d loped brains. In th second place w must rem mbe that n arl all th other and more important diff re ces between man and th Quadrumana are manif tl ad p- t th nature and relat chi fly t th

of seals ... ...
importance f ad pti haract rs f classificati n. These animals diff r from all th r Carnivora in th f rm of th ir bodies and th truct re of th ir limbs, far m re than does man from th hi h pes v t in mo t s- t ms, from that of C t th mo t rece t b M Flow seals are ranked as m re family in th Ord of th Carni ora. If man had t bee hi wn classifi h w uld have tho ght of f unding a separat rd f r his wn recept n.

It would be be nd m limits, and quit beyond m knowledg n t nam th n num rable points of tru ture in whi h man agrees with th th prim tes. Our gre t anatomist and phil soph Prof Huxl has full discussed thi subject, and co l d that man in all parts of his rganizat differs less from th high pes, than these d from the low m mbers of th sam gro p. Consequentl th re is n justificati n f placin man d tinct n.

In an earl part f this w k I bro ght f ward ano facts, h wi g how l sel man agree in const t ti with th high mammals and this agreem t must d pend ur lose similarit min t tructure and h m ical compos t n. I g as nstances, ur liabilit t th sam d seases, and t th t tacks of alli ed parasites our tastes in comm for th sam tim lants, and th similar ffects produced b them, as w ll as by ari us drugs, and other uch facts.

As mall nimportant points of resemblance bet ee man and th Quadrumana are not commonl noticed t matic works, and as, be umerous, the learly re eal ur relationship, I ill pecif f w uch points. The relati e posit n f our f tures is manif tly the sam and the vari us m ti ns are displayed by n arl similar mov m nts of th muscle and ...kin, hi fly bo the brows and round the m th. Some few expressi ns ... deed lmo t th same as in th weeping

and in ... ...
ears are curi sly alik In man the n se is m ch m re promin t than in most monke b t w may trace th comme cem nt of an quilin curv ture n the nose f th Hoolock gibbon and thi in th *Semnopithecus nasica* carried to a ridiculous xtreme.

Th faces of many m nkeys are ornam nted with beards, whi...k rs, o mou...taches. The hair n the h ad grow to a great l ngth in som peci f Semn p thecus and in the bo t m k y (*Macacus rad atus*) t radi tes

... ...
t al appearance b t the thick hair on the h ad of th bonn t m nk y t rmin tes down wards abruptl and ceeded by hair so sh rt and fin that t a littl di-tance th f re- h ad w th th exception f th y brows, appears quit naked. It has been rro eo ly asserted th t ebrows are n t present in any m nk In th peci ju...t named th d gree of nakedness f th f reh ad diff rs in diff rent indi d als and Eschri ht tates that in ou childre th limit between th hairy scalp and th naked f reh ad som times t w ll d fined so th t b re w seem t ha e a trifling case of re rsi n to pro nit in wh m th f reh ad had n t as t becom quite naked.

It is well known th t th hair on ou arms t nds t con rg from abo and below to a point t th lbow This curi us arrangement so unlik that in most f the l w mammals, is comm to th gorilla, chimpanzee orang, som species f Hylobates, and en to some f w Am rican monk ys. B t in *Hylobate gilis* th hai on th f re-arm directed d wnwards t wards th wrist n th ordinary mann and in *H lar* t arl rect, w th onl a ry slight f rward inclinati so that in this latte species t in a transitional tate. It can hard

Proceed ... Zoological Soc ... 1863, p. 4.
Evidence as to M ... Place in Nature, 1863, p. 0, et passim.

Isidore Geoffroy st Hilaire *Hist. Nat. G n.*, tom. ii, 1859 p. 21
... Über die Richtung der Haare, &c., Müller *Archiv fur Anat. nd Phy* 183 s. 51.

ly be doubted that with most mammals the thickness of the hair on the back and its direction is adapted to throw off the rain even the transverse hairs on the fore legs of a dog may serve for this end when he is coiled up asleep Mr Wallace who has carefully studied the habits of the orang remarks that the convergence of the hair towards the elbow on the arms of the orang may be explained as serving to throw off the rain for this animal during rainy weather sits with its arms bent, and with the hands clasped round a branch or over its

seems probable the direction of the hair on our own arms offers a curious record of our former state for no one supposes that it is now of any use in throwing off the rain nor in our present erect condition is it properly directed for this purpose

It would however be rash to trust too much to the principle of adaptation in regard to the direction of the hair in man or his early progenitors for it is impossible to study the figures given by Eschricht of the arrangement of the hair on the human fœtus (this being the same as in the adult) and not agree with this excellent observer that other and more complex causes have intervened The points of convergence seem to stand in some relation to those points in the embryo which are last closed in during development There appears also to exist some relation between the arrangement of the hair on the limbs and the course of the medullary arteries [9]

It must not be supposed that the resemblances between man and certain apes in the above and in many other points—such as in having a naked forehead long tresses on the head &c —are all necessarily the result of unbroken inheritance from a common progenitor or of subsequent reversion Many of these resemblances are more probably due to analogous variation which follows as I have el e where attempted to sl ew from co-descended organisms having a similar constitution and having been acted on by like causes inducing similar modifications With respect to the similar direction of the hair on the fore arms of man and certain monkeys as this character is common to almost all the anthropomorphous apes it may probably be attributed to inheritance but this is not certain as some very distinct American monkeys are thus characterised

Although as we have now seen man has no just right to form a separate Order for his own reception he may perhaps claim a distinct sub order or family Prof Huxley in his last work [11] divides the primates into three suborders

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genera of lemurs As far as differences in certain important points of structure are concerned man may no doubt rightly claim the rank of a sub order and this rank is too low if we look chiefly to his mental faculties Nevertheless from a genealogical point of view it appears that this rank is too high and that man ought to form merely a family or possibly even only a sub family If we imagine three lines of descent proceeding from a common stock it is quite conceivable that two of them might after the lapse of ages be so slightly changed as still to remain as species of the same genus whilst the third line might become so greatly modified as to deserve to rank as a distinct sub family or even Order But in this case it is almost certain that the third line would still retain through inheritance numerous small points of resemblance with the other two Here then would occur the difficulty at present insoluble how much weight we ought to assign in our classifications to strongly marked differences in some few points —that is to the amount of modification undergone and how much to cl e resemblance in numerous unimportant points as in heating the lines of descent or genealogy To attach much weight to the few but strong differences is the most obvious and perhaps the safest course though it appears more correct to pay great attention to the many small resemblance as giving a truly natural classification

In forming a judgment on this head with reference to man we must glance at the classification of the Simiadæ This family is divided by almost all naturalists into the catarhine

[9] Quoted by R d *African Sk tch Book* v l 1 1873 p 152

J A 1868, p 318

In I t oduct n to the Clas f tio f A mals 1869 p 99

gro p, or Old W ld m nkeys, all of which are charact rised (as th nam xp sses) by th peculiar tructure f th no trils, d by f u premolars n ach j w and nto th platy l gro p N w W ld m nkey (ncluding t ers distı ct b g p) all f l ch are charact rised by d ff rently con tru ted trils, and b h n ıx prem lars ch w Som tl m ll d ff ce might

f w f t m ch impo tance l ppare tly f an ad pt n t re It tl f re g nst all probab l ty that som N w W ld pecıes sh uld ha f m ly aried an l p od ced a man lık cre ture w th all tl e d t tı haracters p pe t tl Old W ld d losı g at th sam tım ll ts wn d tı tı l ct ra Tl an, co seq tl hardly b

th catarhı d ıs n.[1]

Th anth pom rpl pes, nam ly the g lla, chimpanzee, ang and Hyl b tes, are by m t nat al t separ ted from th th Old W ld monkeys, as a dist t b-gro p I am ar th t G t l t, ly g n th tru t re f th b aın, doe n t admit the xı t nce f th b-gro p and no d bt t a brok Th th ang, as M St. G Mı art remarks, ıs f th most pec liar and aberrant f rm to be f d th Ord [2] Th remaı g antl ropom rpl us Old W ld m k ys, are agaı dı ded by som nat ralıst t t three mall b-gro ps tl g S mn p thecus, w th ts peculı ar sacc lated t mach being th type f ne b-gro p B t t ppears from M Gau dry d rf l disc n n Att ca, that l n g th M oce period f rm ısted th re wl h co ected Semn p thecus nd Macacus and tl probably ll tr te th

mann ı which th oth and high r groups w re c ble ded togeth r

If th nthropom ph pes be admitted to f rm nat l b-group th n s m n t th m t nly n all th se char

nfe th t so e an t m mber of th a thropom rph s ub p g b rth t man. It ıs n t prob bl that, thr gh th l w of al g r tı n, m mbe f o f th oth l w r b-gro p sl ld h gı n se to a man lık cr atu r semblı g the l gh r anth pomo ph u p ın so many re pects No d l t m ı comp rıso wıtl most of his

th t l s but f seve al e cept al f m f prim tes

E y n t ah t who b l e e n th prı cipl f l tıon, w ll g ant tl at the tw main dı ıs ns f th Simiadæ nam ly the catarh and platy h m nk ys, with their b-gro ps, h ll proceeded from som e trem ly a nt prog nıt Th arly d

gro p b t som f th pecı s r incıp nt g n er w uld h l eady b gun to ındicat by th ı dı gıng charact rs the f ture d t t marks of th catarh e and pl tyrhı e d ns. H th m mb f thı pposed anc t gro p wo ld n t h been so uniform th d nt tı n, th tr cture f th ır n t ls, as ar th xıstı g catarhın m nk ın new y and th pl ty hı es ın an th w y b t w ld h resembled ın th re pect th all ed Lem ridæ wl ch diff gre tly from ach th ın th f rm f th ır muzzl s, and to an t ao dinary d g ee n th r d tıt n

Th cata hın and pl ty hıne m nk y gree m ltıt d f characters, as sh wn by th unq est onably bel gıng t and th sam Ord Th many charact rs wh h th y possess comm ca hardly h b nd pend ntly acquired by so many dıst ct pecı s so th t these charact rs m t ha

[1] In these t latter gro ps ns en g t th l la y hine M M rt till b dea by th same see Nat 1871 p 4 1

[2] Transactions, Zoolog Soc., vol. ı., 1867 p 214

Mr St. G M art, Transactions f the Pl ılosoph ıcal Socıety 1867 p 410

Messrs. Mune d M art the Lemuro dea, Transact ns Zoologıcal Society l ıı, 1869 p 5

been inherited But a naturalist would undoubtedly have ranked as an ape or a monkey an ancient form which possessed many characters common to the catarhine and platyrhine monkeys other characters in an intermediate condition and some few perhaps distinct from those now found in either group And as man from a genealogical point of view belongs to the catarhine or Old World stock we must conclude however much the conclusion may revolt our pride that our early progenitors would have been properly thus designated [16] But we must not fall into the error of supposing that the early progenitors of the whole simian stock including man was identical with or even closely resembled any existing ape or monkey

On the Birthplace and Antiquity of Man — We are naturally led to enquire where was the birthplace of man at that stage of descent when our progenitors diverged from the catarhine stock? The fact that they belonged to this stock clearly shews that they inhabited the Old World but not Australia nor any oceanic island as we may infer from the laws of geographical distribution In each great region of the world the living mammals are closely related to the extinct species of the same region It is therefore probable that Africa was formerly inhabited by extinct apes closely allied to the gorilla and chimpanzee and as these two species are now man s nearest allies it is somewhat more probable that our early progenitors lived on the African continent than elsewhere But it is useless to speculate on this subject for two or three anthropomorphous apes one the Dryopithecus of Lartet nearly as large as a man and closely allied to Hylobates, existed in Europe during the Miocene age and since so remote a period the earth has certainly undergone many great revolutions and there has been ample time for migration on the largest scale

At the period and place whenever and wherever it was when man first lost his hairy covering he probably inhabited a hot country a circumstance favourable for the frugi

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ferous diet on which judging from analogy he subsisted We are far from knowing how long ago it was when man first diverged from the catarhine stock but it m h

l as early as tl

may be modified under favourable circumstances we know however that some have retained the same fo

at all some a little and some greatly changed all within the same period Thus it may have been with man who has undergone a great amount of modification in certain characters in comparison with the higher apes

The great break in the organic chain between man and his nearest allies which cannot be bridged over by any extin t

ppear of much weight to those who from general reasons believe in the general principle of evolution Breaks often occur in all parts of the serie some being wi le sharp and defined others less so in various degrees as between the orang and its nearest allies—between the Tarsius and the other Lemuridæ—between the elephant and in a more striking manner between the Ornithorhynchus or Echidna, and all other mammals But these breaks depend merely on the number of related forms which have become extinct. At some future period not very distant as measured by centuries the civilised races of man will almost certainly exterminate and replace the savage races throughout the world At the same time the anthropomorphous apes as Professor Schaaffhausen has remarked [18] will no doubt be exterminated The break between man and his nearest allies will then be wider for it will intervene between man in a more civilised state as we may hope even than the Caucasian and some ape as low as a baboon instead of as now between the negro or Australian and the gorilla.

With respect to the absence of fossil remains serving to connect man with his ape like progenitor no one will lay much stress on this

[16] Dr C Forsyth Major Sur les singes fossils trouvés en Italie Soc Ital. des Sc. Nat., t xv

18 —

[18] Anthropological Review April, 1867 p 236.

fact wh read S r C Ly ll d scuss is t wl reh sl that i all th ert b t classe th disco ery f f ss l remains has been a ry l w and f rt t us process. N r ho ld t be t f g tt th t tl se reg s wl cl are the t most lik l t aff rd rem ns connect g man w th som t t pe l k reature h n t as y t bee se rched by geol gists. f ble co currence of circ m tances

Low St g the Gen alogy f M —We h see that man t pear to h e d r ed from tl catarh Old W ld d n f tl S m adæ aft th e had di e ged from the New W ld d We will w d ur t f ll w th rem te t aces f h s g n al gy trusti g pri cipally t th m t al affinit be-twee tl n s classes nd rd rs, w th som l ght f ce t tl periods, as far as

re t

In attempti g to t ace tl genealogy of tl e Mammalia, and th f f *man*, l w r d n t the ser s, w become n l ed n great r and gre t obscurity b t as a mo t cap ble

H wh wi he *to* see wh t *ing* u ty nu knowledg can ffect, m y consult Prof H ec kel w ks.[21] I will cont nt myself with fe g n al remarks. E ry l t om t will dm t th t th fi gre t rt brate classes, nam l m mmals, b rds, reptil s, amph bians d fish s, are d sce ded fro t som ne proto-type f tl y ha m ch n common s pec ally dun g th mb yo tat As tl e class f fish th m t l wly o ganised and ppeared b f re th th s, w may co l d that ll th m mbers of th rtebrat k g d m re d n ed from some fishlik anim l Th beh f th t animal so d ti ct as a mo k an lephant h mming b rd a ak a frog and fi h &c. co ld all h prung from th sam pare ts, w ll ppear m t u to th se wh ha n t tt nded t th rec t progress f nat al hi t ry F thi bel f m pl es th former t nce of links b d g l sely t g th all th se fo ms, n w so utte ly u il k

N rtl l ss t ce ta that gro ps of animals h ted d now xist, which se to co ect se l f th great rte b t lasse m re l ss l sel We h e seen tl t th Orn th hy ch g ad tes towards rept les and Prof Huxl y has d sco ed d is confirmed by M Cope and thers, th t tl

t Haeck l d th rs, di tin t Ord l h gro p d rsified and brok n t an tra rd nary d gree and l d many be ant f rms. It has, th ref re prol ably ff red m l t ct M t f tl rem ants lands, h as Mad gascar and tl Mal yan arcl pel g wl re th y h e t bee posed t so se re compet ti n as th y w ld ha bee w ll tocked co l

tl re b t t p as t seems, t th l est, mallest and l ast t ll g t f tl place tal mammal a. From tl se ari consid a- t t prol abl th t tl S m adæ w re gi all d loped from th p g nit rs f th xi ti g Lem dæ d th se th t m from f rms tand ry l w in th mam mal an seri s.

Tl mars p ls tand many mport t haract rs below tl place tal mammals Th y t peared t an arl geol g al period and th ang was f rm l m l m re t tl an t t rese t H ce tl l lace t t are ge rall ppos l t l bee l n ed from tl Iml lace tata mars t als n t l from f rms losel resembl g th t g mars p ls, t t from tl l prog tor Tl M notrem t are plai ly all ed t

Elements of Geology 1865 pp. 583-585 *Ant quity of M* n, 1 3, p 145

M *l la Nat* p. 105.

[21] El bo t t bles ar gi his *Gener ll Mor phol g* (B s. ch d s. 425) and w th m re espec l ref cet ia his *Nat liche Schöpf gs-g schichte* 1868 l rof Huxl y re g this latt w k (*Th Acad y* 1869 p 42) say that h cons d rs th phyl m l of desce t f th V te-brat t be dm rably discus ed by Haeck l l though he d ff rs som po ts. H expresses, lso his h gh est m t f th g al t d pir t f the hol ork.

dinosaurians are in many important characters intermediate between certain reptiles and certain birds—the birds referred to being the ostrich tribe (itself a widely diffused remnant of a larger group) and the Archeopteryx that strange secondary bird with a long lizard like tail Again according to Prof Owen [22] the ichthyosaurians—great sea lizards furnished with paddles—present many affinities with fishes or rather according to Huxley with amphibians a class which including in its highest division frogs and toads is plainl ...

... lied affinities with other groups of organism The Lepidosiren is also so closely allied to amphibians and fishes that naturalists long disputed in which of these two classes to rank it it and also some few ganoid fishes have been preserved from utter extinction by inhabiting rivers which are harbours of refuge and are related to the great waters of the ocean in the same way that islands are to continents

Lastly one single member of the immense and diversified class of fishes namely the lancelet or amphioxus is so different from all other fishes that Haeckel maintains that it ought to form a distinct class in the vertebrate kingdom This fish is remarkable for its negative characters it can hardly be said to possess a brain vertebral column or heart &c so that it was classed by the older naturalists amongst the worms Many years ago Prof Goodsir perceived that the lancelet presented some affinities with the ascidians which are invertebrate hermaphrodite marine creatures permanently attached to a support They hardly appear like animals and consist of a simple tough leathery sack with two small projecting orifices They belong to the Mulluscoida of Huxley—a lower division of the great kingdom of the Mollusca but they have recently been placed by some naturalists amongst the Vermes or worms Their larvæ somewhat resemble tadpoles in shape [23] and have the power of swimming freely about. Mr Kovalevsky [24] has lately observed that the larvæ of ascidians are related to the Verte...

... has now carried these observations yet further and should his results be well established the whole will form a discovery of the very greatest value Thus if we may rely on embryology ever the safest guide in classification it seems that we have at last gained a clue to the source whence the Vertebrata were derived [25] We should then be justified in believing that at an extremely remote period a group of animals existed resembling in many respects the larvæ of our present ascidians, which diverged into two great branches—the one retrograding in development and producing the present class of ascidians the other rising to the crown and summit of the animal kingdom by giving birth to the Vertebrata.

We have thus far endeavoured rudely to trace the genealogy of the Vertebrata by the aid of their mutual affinities We will now look to man as he exists and we shall I think be able partially to restore the structure of our early progenitors during successive periods, but not in due order of time This can be ef...

...version and by the aid of the principles of morphology and embryology The various facts to which I shall here allude have been given in the previous chapters

The early progenitors of man must have been once covered with hair both sexes having

by m u d r as mples c ca pe pla ly di ded by transverse paque partiti ns, h ch I presume rep-

[25] B t I b l t ll tl t so m p t t

po t f d ntal d type t t é (F t nce d co d d l) l ent brl pa l l co l t nt l d l d plat t tt mjd l bil lè l pas g pp e F lim t le d ue ue gne ncor Lien q g pa le pa ge t f it éalué."

bears thei ears were probably pointed, nd capable of mo m nt and thei bodies were pro ided with a tail, h ng the proper mus-les. Their limbs and bod es w re also acted n l man muscles which now only occasi nally rea pear b t are n rmall present in th Quadrumana. At this or som arli period the great artery and n rve of th hum rus ran through a supra-condyloid foram n. The in testine g forth much larg di rticul m or cæcum than that n w xisti g Th foot was the prehensile j dgi g from th conditi n of the gre t toe the fœtus and ur pro nitors, no d bt, w re arboreal in th ir hab ts, and freque ted som warm, f rest-clad land Th males had great canin teeth, whi h served them as f rmidable weapons. At a m ch ar li period the ut rus was d ubl th excreta w re oided through a loaca and th was protected by a third yelid nictitating m m brane. At till earlie period th prog nit rs of man m st ha e been quati th ir hab ts f m rphology plainly t lls us that our lungs consist of modified swimbladd which nce served as float. Th cl fts n the neck in th mbry of man show where th branchiæ once existed. In the l nar weekly recurrent periods of som of our f ti ns w ppare tly still retai traces of our primordial birthplace, shore washed by th tides. At abo t this sam earl period th tru kid ys w re replaced b the corpora w lffiana. Th h art xisted as simple p lsating essel and th hord dorsalis took the place f a rt bral column. These arly ance t rs f man, thus see in th dim recesses f tim must h e been as simpl or still more impl or ganised than the lancelet amphioxus.

There is on th point deserv ng a f lle notice It has long been known that in th rt brat kingdom se bears rudiments of an accessory parts, ppertaining t the reproducti t m which properly belo g to the posit se and t has w been asce tained that at ry arl mbryoni period both se es possess true male and f male glands. H nce om remot pro nito of th wh le rtebrat kingdom ppears to ha been h rmaphr d te or androgynous.[34] B t here w encount r singular difficulty In the mam malian class the males possess rud m nts f a uterus with the adjacent passage, n th eir vesiculæ prostaticæ th y bear also rud m nts of mammæ and som al marsupials ha e trace of a mars pial sack.[35] Oth r analog us facts could be added. Are we th n, to suppose that som trem ly anci nt mammal con tin ed androgyn us, afte it had acquired the chief distincti ns of its class, and th refore aft t had di erged from the l w r classes f the rt brate kingd m This seems ery im probable, f we h to look to fishes, the l est f all th classes, to find any still exist e t androgynous f rms.[36] That various accessory parts, prope to each sex, are f und in a rudim ntary conditi n in the oppo te sex,

thus f rm f transmissi n,—as in the case of the sp rs, plumes, and brilliant colours, ac quired f battl or rnament by male birds, and inh rited by the f males in an imperfect or rudim tary conditi n.

The possession by male mammals of func ti nall imperfect mammary organs is, in som respects, pecially curi us. The M notremata ha the proper milk secreting glands with orifices, b t n nipples and as these animals stand at the ry base f th mammalian series, t is probabl that th prog nitors of th class also had milk secretin glands, b t no nipples. This conclusion is supported by wh t is kn wn f th ir mann of d lopm nt for Professo T rn nf rms m on the auth rity of K llik and Lang th t in th mbryo th mammary glands can be distinctly traced be f re th nipples are n th l ast sibl and th

[34] This the lusio f Prof Geg baur one of the hi hest uthor ies comparat tomy see *Grundzüge der vergleich. Anat.* 1870, s 876 The re- su ha been arri t hiefly from the study of the Amphibia b t ppears from the researches of Waldeyer quo ed *Journal of Anat. and Phys.*, 1869, p. 161), ha he sexual organs of ev the h her rtebrata are in their early condition, her-maphrodite. Similar view ha e long bee held by some thors, tho h until rece tly without firm basis.

[35] The male Th lacinus offers the best instance. Ow n, *Anatomy f V ertebrates*, l iii, p. 771

[36] Hermaphroditism has bee observed se ral species of Serranus, as w ll as in some ther fishes, here t is either ormal d symmetrical, or b-normal d ilateral. Dr Zouteveen has gi m references this bject, more especially to paper by Prof Halbertsma, in th *Transact. f the Dutch Acad. of Science* ol. x. D Gü ther doubts the fact, but t has now bee recorded by too ma y good observers t be any lo ger disputed. D M. Lesso writes t me that he has erified the obser ti ns mad by Ca olini Serra us. Prof Ercolani ha rece tly show (*Acad. delle Scienze* Bologna, Dec. 28, 1871) that eels are androgynous.

development of successive parts in the individual generally represents and accords with the development of successive beings in the same line of descent. The marsupials differ from the Monotremata by possessing nipples, so that probably these organs were first acquired by the marsupials, after they had diverged from, and risen above, the Monotremata, and were then transmitted to the placental mammals.[29] No one will suppose that the marsupials still remained androgynous after they had approximately acquired their present structure. How then are we to account for male mammals possessing mammæ? It is possible that they were first developed in the females and then transferred to the males, but from what follows this is hardly probable.

It may be suggested, as another view, that long after the progenitors of the whole mammalian class had ceased to be androgynous, both sexes yielded milk, and thus nourished their young; and in the case of the marsupials, that both sexes carried their young in marsupial sacks. This will not appear altogether improbable, if we reflect that the males of existing syngnathous fishes receive the eggs of the females in their abdominal pouches, hatch them, and afterwards, as some believe, nourish the young;[30]—that certain other male fishes hatch the eggs within their mouths or branchial cavities;—that certain male toads take the chaplets of eggs from the females, and wind them round their own thighs, keeping them there until the tadpoles are born;—that certain male birds undertake the whole duty of incubation, and that male pigeons, as well as the females, feed their nestlings with a secretion from their crops. But the above suggestion first occurred to me from mammary glands of male mammals being so much more perfectly developed than the rudiments of the other accessory reproductive parts, which are found in the one sex though proper to the other. The mammary glands and nipples, as they exist in male mammals, can indeed hardly be called rudimentary; they are merely not fully developed, and not functionally active. They are sympathetically affected under the influence of certain diseases, like the same organs in the female. They often secrete a few drops of milk at birth and at puberty: this latter fact occurred in the curious case before referred to, where a young man possessed two pairs of mammæ. In man and some other male mammals these organs have been known occasionally to become so well developed during maturity as to yield a fair supply of milk. Now if we suppose that during a former prolonged period male mammals aided the females in nursing their offspring,[31] and that afterwards from some cause (as from the production of a smaller number of young) the males ceased to give this aid, disuse of the organs during maturity would lead to their becoming inactive; and from two well-known principles of inheritance, this state of inactivity would probably be transmitted to the males at the corresponding age of maturity. But at an earlier age these organs would be left unaffected, so that they would be almost equally well developed in the young of both sexes.

Conclusion.—Von Baer has defined advancement or progress in the organic scale better than any one else, as resting on the amount of differentiation and specialisation of the several parts of a being,—when arrived at maturity, as I should be inclined to add. Now as organisms have become slowly adapted to diversified lines of life by means of natural selection, their parts will have become more and more differentiated and specialised for various functions from the advantage gained by the division of physiological labour. The same part appears often to have been modified first for one purpose, and then long afterwards for some other and quite distinct purpose; and thus all the parts are rendered more and more complex. But each organism still retains the geological evidence, that organisation on the whole has advanced throughout the world by slow and interrupted steps. In the great king

[29] Prof. Gegenbaur has shewn (*Jenaische Zeitschrift*, Bd. vii. p. 212) that two distinct types of nipples prevail throughout the several mammalian orders, but that it is quite intelligible how both could have been derived from the nipples of the marsupials, and the latter from those of the Monotremata. See also a memoir by Dr. Max Huss, on the mammary glands, *ibid.* B. viii. p. 176.

[30] Mr. Lockwood believes (as quoted in *Quart. Journal of Science*, April 1868, p. 269), from what he has observed of the development of Hippocampus, that the walls of the abdominal pouch of the male in

[illegible] *Anatomy and Physiology*, Nov. 1866, p. 78. Dr. Günther has likewise described similar cases.

[31] Mlle. C. Royer has suggested a similar view in her *Origine de l'homme*, &c., 1870.

d m of the V rt brata t has culminated n man. It mu t t, h w be pposed that gro p f organic be g are alw ys pplanted and disap pear as soo as th ha e gi n b rth t th and m re perfect gro ps. Tl latt r tho gh ctori us th predecessors, t h become bett adapted f all

posed t ery se re competiti n and u se oft aid us in constru ti g ur g al gi s, by gi ing us fair d f f rm and lost popula- ti ns. B t e must n t fall into th ror f looki g t th xi ting m mbers f any l wly rganised group as perfect represent ti es f th ir anci t p edecessors.

Th m t ancient prog nit rs in th ki d m of th V rtebrata, t which w are abl to obtai an bscure glance ppare tly consisted f gro p I mari animals,[33] resemblin th larvæ f xi ti g asc d ans. These animals prob bly g rise to gro p of fishes, as lo l gan sed as the lancel t and from th se th gan ds, and th fisl es l k th Lep dosiren. m t ha bee d loped From s ch fish ry small ad ance w ld carry us to tl amphibians. W h see th t b rd and reptiles w re ce timat ly connected to- g th and th M trem ta n w connect mammals th reptiles slight d gree. B t no can at present say by wh t lin f de-

scent the three high r and related classes, nam ly mammals, birds, and reptiles, were d ri ed from the two l w r vert br t classes, namely amphib ans and fishes. In the class of mammal th st p are n t difficult to con ce which led from th ancient M notremata t the anci nt mar p als and from th se to th arly progenit rs of th placental mam mals. W may thus ascend t the Lemuridæ and the t al i n t ry wide from th se to th Simiadæ. The Simiadæ then b anched off int tw gre t tems, the N w W ld and Old W o ld m nk ys and from the latter t re- m t period Man, th w d and gl ry of th Un rse proceeded

Th we h gi en to man a pedigree of prod gi us l ngth b t n t, it may be said f n bl q ality Th w rld it has often been remarked ppears as f it had l ng been pre n ri g f th ad nt f man and this, in on

h e been exactly wh t he n w s. Unl ss w wilfully cl se ur yes, w m y with ur pres- t kn wled e, pproxim t ly recognise o r pare tag eed we feel ashamed of t. Th m t humbl ganism somethin much

stru t re and properti s.

[33] The habita ts of th seashore must be greatly affected by th t des mals h g either bo t th me high- ter mark, or bo t the me low w t mark, pass thro gh compl t cycl of tidal cha ges

the course regular eekly perioda. N w t is m erous fact that in the h gh d ow t rres- trial Vert brata, as ll as ther lasses, ma y normal nd b ormal processes ha e more bole eeks as th ir perrods thus ld be rend red lli ble if the Vert brata re desce ded from mal allied the ex t g tidal ascidia M y instances of h periodic processes m ght be gi n, b est t of mammals, the dur tio of f ers, &c. The hatchi g of eggs affords also good ex

mpl for according t M Bartlett (*Land nd Water* J n. 7 18 1), th ggs of the p geo re h tched tw weeks those of th f wl three those of th d k f ur those f th goose fi

CHAPTER VII

ON THE RACES OF MAN

It is not my intention here to describe the several so-called races of men; but I am about to enquire what is the value of the differences between them under a classificatory point of view, and how they have originated. In determining whether two or more allied forms ought to be ranked as species or varieties, naturalists are practically guided by the following considerations; namely, the amount of difference between them, and whether such differences relate to few or many points of structure, and whether they are of physiological importance; but more especially whether they are constant. Constancy of character is what is chiefly valued and sought for by naturalists. Whenever it can be shewn, or rendered probable, that the forms in question have remained distinct for a long period, this becomes an argument of much weight in favour of treating them as species. Even a slight degree of sterility between any two forms when first crossed, or in their offspring, is generally considered as a decisive test of their specific distinctness; and their continued persistence without blending within the same area, is usually accepted as sufficient evidence, either of some degree of mutual sterility, or in the case of animals of some mutual repugnance to pairing.

Independently of fusion from intercrossing, the complete absence, in a well-investigated region, of varieties linking together any two closely allied forms, is probably the most important of all the criterions of their specific distinctness; and this is a somewhat different consideration from mere constancy of character, for two forms may be highly variable and yet not yield intermediate varieties. Geographical distribution is often brought into play unconsciously and sometimes consciously; so that forms living in two widely separated areas, in which most of the other inhabitants are specifically distinct, are themselves usually looked at as distinct; but in truth this affords no aid in distinguishing geographical races from so-called good or true species.

Now let us apply these generally admitted principles to the races of man, viewing him in the same spirit as a naturalist would any other animal. In regard to the amount of difference between the races, we must make some allowance for our nice powers of discrimination gained by the long habit of observing ourselves. In India, as Elphinstone remarks, although a newly-arrived European cannot at first distinguish the various native races, yet they soon appear to him extremely dissimilar;[1] and the Hindoo cannot at first perceive any difference between the several European nations. Even the most distinct races of man are much more like each other in form than would at first be supposed; certain negro tribes must be excepted, whilst others, as Dr. Rohlfs writes

lection Anthropologique du Muséum de Paris of the men belonging to various races, the greater number of which might pass for Europeans, as many persons to whom I have shewn them have remarked. Nevertheless, these men, if seen alive, would undoubtedly appear very distinct, so that we are clearly much influenced in our judgment by the mere colour of the skin and hair, by slight differences in the features, and by expression.

There is, however, no doubt that the various races, when carefully compared and measured, differ much from each other,—as in the texture of the hair, the relative proportions of all parts of the body,[2] the capacity of the lungs, the form and capacity of the skull, and even in the convolutions of the brain.[3] But it would be an endless task to specify the numerous points of difference. The races differ also in constitution, in acclimatisation and in liability to certain diseases. Their mental characteristics

[1] 'History of India,' 1841, vol. i. p. 323. Father Ripa makes exactly the same remark with respect to the Chinese.

[2] A vast number of measurements of Whites, Blacks, and Indians, are given in the 'Investigations in the Military and Anthropolog. Statistics of American Soldiers,' by B. A. Gould, 1869, pp. 298-358; 'On the capacity of the lungs,' p. 471. See also the numerous and valuable tables, by Dr. Weisbach, from the observations of Dr. Scherzer and Dr. Schwarz, in the 'Reise der Novara: Anthropolog. Theil,' 186[illegible].

[3] See, for instance, Mr. Marshall's account of the brain of a Bushwoman, in 'Philosophical Transactions,' 1864, p. [illegible]19.

are likewise ery distinct chi fly as it w uld pear in their m ti nal, b t partl in their intellectual faculties. E ery who has had the pportunity of comparison, must ha been struck with th co trast between th taciturn, e en morose, aborigin s f S. Am rica and the lighthearted, talkati n groes. Th re is nearl similar co trast between th Ma la s and th P puans, who li und the same pl sical conditi ns, and are separated from each th nly b narrow space of sea.

W will first consid th argum nts which may be ad anced in f ur f classing the races of man as distinct pecies, and then the argum ts on th other side. If nat ralist, who had ne er bef re seen N gro, Hottentot, A stralian, or M ngolian, w re to compare them, he w uld nce perceive that the differed in multitud of characters, som of slight and som of considerable importance. On quiry h would find that th y were ad pted t h und wid ly diff rent climates, and that they diff red som what in bodil const t tio and m tal dispositi n. If h w re then told that hundreds of similar pecimens could be bro t from th same countries, h ould assuredl declare that th y were as good peci as man t which h had been in the habi t f affixin specific names. This conclusion w uld be gre tly tren thened as soo as he had ascertained that these f rms had all retained the sam character f many cen turies and that groes, pparently identical th xisting negroes, had li ed at least 4000 ears ago H would also h ar on th thor ty of an excell t observ r Dr Lund that th h m k ills f und in th caves of Brazil

geogr ...

ably declare that those f rms mu t be di tinct pecies, which d ff n t only in ppearance b t are fitted f h t, as well as damp or dry countries, and f ti arctic regions. He m ht appeal to the fact that no species in th group n xt to man—namely the Quadrumana, can resist a l w t mperature any consid rabl change of climat and that th speci which come n arest to man ha n r been reared to maturity n unde th tempe ate climate of Europe. H would be deeply impressed with th fact, first noticed by Agassiz, th t th diff rent races of man are distrib ted o the wo ld in th sam zool gical provinces, as th ose inhab ted b und ubtedl disti t pe-

... mann r with th H tt t ts b t plainly with th P puans and Mala s, who are separated as Mr Wallace has sh wn, by n arl th same lin whi h divides th re t Malayan and Australian zoological provinces. Th aborigines of Am rica range thro gh ut the co tin nt and this t first ppears opposed to the abo rul f most of th producti ns f th So th rn and North rn hal es differ widely t som f w livi forms, as th possum, ran from the e into th oth as did f m l som f th gi anti Ed ntata. Th Esq im ux, lik oth arct an.mals, extend ro nd the wh polar regions. It sh uld be observed that th am unt of diff rence bet ee th mammals of th se ral zool gical pro nce does n t correspo d w th th d gree of separati n b tween th. I tt so that t can hardly be consid red as an an maly that th N gro d ff rs more and th Am rican m ch less from th oth races of man, than d th mammal of th African and Am rican con tin ts from th mammals of th oth r pro nces. Man, t may be added does not ppear t have aboriginally inhabited an ocean.

Wallace *The Malay Archipelago*, vol. ii., 1869 p. 178

With respect t the figures in the famous Egyptian ca es of Abou-Simbel, M. Pouchet says (*The P ra of the H ma Races*, Eng transl., 1864 p. 50) that he as far from finding recognisable representativ ns of the dozen or more nations which me uthors be ev tha they ca recogn se. E e

Types of Mankind, p. 14 stat that Rameses II, or he G e t, has features superbly European, Serres Knox, another firm believer in the specific distinctness of the races of ma *Races of M n*, 1850, p. 26) speak g of young Memnon (the same as Rameses II., as I am formed by M Birch), n sts in the stro est manner that he is identical in aracter th the Jew of A t erp. Again, he I k ed at the statue of Am noph III, I agreed th officers of the establishme t, both competent ju ges, that he had strongly-marked negro ype of f ures but Messrs. Nott and Glidd n (ibid., p. 146, fig. 53), describe him as hybrid, but not of negro intermixture.

As quoted by N tt and Gliddon, *Types of M nkind* 1854, p. 439 Th gi also corroborati evidence but C V gt th nks that the subject requires further in estigatio

Di ersity f Origin of th Human Races, in the *Christian Examiner* July 1850.

island and in this respect he resembles the other members of h

I ... or as specifically distinct that is whether any of them are descended from distinct wild species every naturalist would lay much stre ... their ex tinct All ... act as it ... xceptional one for I am informed by Mr Denny that the most different kinds of dogs fowls and pigeons in England are in fested by the same species of Pediculi or lice Now Mr A Murray has carefully examined the Pediculi collected in different countries from the different races of man[8] and he finds that they differ not only in colour but in the structure of their claws and limbs In every case in which many specimens were obtained the differences were constant The surgeon of a whaling ship in the Pacific assured me that when the Pediculi with which some Sandwich Islanders on board swarmed strayed on to the bodies of the English sailors they died in the course of three or four days These Pediculi were darker coloured and appeared different from those proper to the natives of Chiloe in South America of which he gave me speci mens These again appeared larger and much softer than European lice Mr Murray procured four kinds from Africa namely from the Negroes of the Eastern and Western coasts from the Hottentots and Kaffirs two kinds from the natives of Australia two from North and two from South America In these latter cases it may be presumed that the Pediculi came from natives inhabiting different dis tricts With insects slight structural differ ences if constant are generally esteemed of specific value and the fact of the races of man being infested by parasites which appear to be specifically distinct might fairly be urged as an argument that the races themselves ought to be classed as distinct species

Our supposed naturalist having proceeded thus far in his investigation would next en quire whether the races of men when cro se l were in any degree ste ile He might consult the work of Professor Broca a cautious and philosophical observer and in this he would find good evidence that some races were quite fertile together but evidence of an opposite nature in regard to other races Thus it has been asserted that the native women of Aus tralia and Tasmania rarely produce children to European men the evidence however on this head has now been shewn to be almost valueless The half castes are killed by the pure blacks and an account has lately been published of eleven half caste youths murdered and burnt at the same time whose remains were found by the police[10] ... been ...

... positively as s ... that he has known mulatto families which have intermarried for several genera tions and have continued on an average as fertile as either pure whites or pure blacks. Enquiries formerly made by Sir C Lyell on this subject led him as he informs me to the same conclusion[12] In the United States the census for the year 18 4 included according to Dr Bachman 405 751 mulattoes and this number considering all the circumstances of the case seems small but it may partly be ac counted for by the degraded and anomalous position of the class and by the profligacy of the women A certain amount of absorption of mulattoes into negroes must always be in progress and this would lead to an apparent diminution of the former The inferior vitality of mulattoes is spoken of in ... trustworthy wo ... and this, ... om their ... anced as

Tran actions of th Roy l Soc ty f Ed b gh, vol xxii 1861 p 67

O the Phenom n f Hyb idity n the Genus Homo E g tr nslat. 1864

... tt t r ting l tt r by M T A M rray n th Anth polog l R ...

(... Mr l 1869 p 239) mu h d that Au t ha ... d Eu pe ns re n t t l l n er d

f Lx ... Sk t h f the N t l ... f th ... l B ld Ch rl t n 1855 p 44

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... f Amer ... y B A G uld 1869 p 319

a proof of the specific distinctness of their parent races. No doubt both animal and vegetable hybrids, when produced from extremely distinct species, are liable to premature death; but the parents of mulattoes cannot be put under the category of extremely distinct species. The common mule, so notorious for long life and vigour, and yet so sterile, shows how little necessary connection there is in hybrids between lessened fertility and vitality: other analogous cases could be cited.

Even if it should hereafter be proved that all the races of men were perfectly fertile together, he who was inclined from other reasons to rank them as distinct species, might with justice argue that fertility and sterility are not safe criterions of specific distinctness. We know that these qualities are easily affected by changed conditions of life, or by close interbreeding, and that they are governed by highly complex laws, for instance, that of the unequal fertility of converse crosses between the same two species. With forms which must be ranked as undoubted species, a perfect series exists from those which are absolutely sterile when crossed, to those which are almost or completely fertile. The degrees of sterility do not coincide strictly with the degrees of difference between the parents in external structure or habits of life. Man in many respects may be compared with those animals which have long been domesticated, and a large body of evidence can be advanced in favour of the Pallasian doctrine, that domestication tends to eliminate the sterility which is so general a result of the crossing of species in a state of nature. From these several considerations, it may be justly urged that the perfect fertility of the intercrossed races of man, if established, would not absolutely preclude us from ranking them as distinct species.

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parent forms ought to be ranked as species or varieties; *but after carefully studying the* evidence, I have come to the conclusion that no general rules of this kind can be trusted. The ordinary result of a cross is the production of a blended or intermediate form; but in certain cases some of the offspring take closely after one parent-form, and some after the other. This is especially apt to occur when the parents differ in characters which first appeared as sudden variations or monstrosities. I refer to this point, because Dr. Rohlfs informs me that he has frequently seen in Africa the offspring of negroes crossed with members of other races, either completely black or completely white, or rarely piebald. On the other hand, it is notorious that in America mulattoes commonly present an intermediate appearance.

We have now seen that a naturalist might feel himself fully justified in ranking the races of man as distinct species; for he has found that they are distinguished by many differences in structure and constitution, some being of importance. These differences have also remained nearly constant for very long periods of time. Our naturalist will have been in some degree influenced by the enormous range of man, which is a great anomaly in the class of mammals, if mankind be viewed as a

The Variation of Animals and Plants under Domestication, vol. ii. p. 109. I may here remind the reader that the sterility of species when crossed is not a specially-acquired quality, but, like the incapacity of certain trees to be grafted together, is incidental on other acquired differences. The nature of these differences is unknown, but they relate more especially to the reproductive system, and much less to the external structure or to ordinary differences in constitution. One important element in the sterility of crossed species apparently lies in one or both having been long habituated to fixed conditions; for we know that changed conditions have a special influence on the reproductive system, and we have good reason to believe (as before remarked) that the fluctuating conditions of domestication tend to eliminate that sterility which is so general with species, in a natural state, when crossed. It has elsewhere been shown by me (*ibid.* vol. ii., p. 185, and *Origin of Species*, this ed., p. 142), that the sterility of crossed species has not been acquired through natural selection: we can see that when two forms have already been rendered very sterile, it is scarcely possible that their sterility should be augmented by the preservation or survival of the more and more sterile individuals; for, as the sterility increases, fewer and fewer offspring will be produced from which to breed, and at last only single individuals will be produced at the rarest intervals. But there is even a higher grade of sterility than this. Both Gärtner and Kölreuter have proved that

lect the more sterile individuals, which have already ceased to yield seeds; so that this acme of sterility, when the germen alone is affected, cannot have been gained through selection. This acme, and no doubt the other grades of sterility, are the incidental results of certain unknown differences in the constitution of the reproductive system of the species which are crossed.

The Variation of Animals, &c. vol. ii., p. 92.

single species He will have been struck with the distribution of the several so called races which accords with that of other undoubtedly distinct species of mammals Finally he might urge that the mutual fertility of all the races has not as yet been fully proved and even if proved would not be an absolute proof of their specific identity

On the other side of the question if our supposed naturalist were to enquire whether the forms of man keep distinct like ordinary species when mingled together in large numbers *in the same country* he would immediately discover that this was by no means the case In Brazil he would behold an immense mongrel population of Negroes and Portuguese in *Chiloé and other parts of South America he* would behold the whole population consisting of Indians and Spaniards blended in various degrees [16] In many parts of the same continent he would meet with the most complex crosses between Negroes Indians and Europeans and judging from the vegetable kingdom such triple crosses afford the severest test of the mutual fertility of the parent forms In one island of the Pacific he would find a small population of mingled Polynesian and English blood and in the Fiji Archipelago a population of Polynesians and Negritos crossed in all *degrees Many analogous cases could be added* for instance in Africa Hence the races of man are not sufficiently distinct to inhabit the same country without fusion and the ab ence of fu ion affords the usual and best test of specific distinctness

Our naturalist would likewi e be much disturbed as soon as he perceived that the di tinctive characters of all the race were highly variable This fact strikes every one on first beholding the negro slaves in Brazil who have been imported from all parts of Africa. The same remark holds good with the Polynesians *and with many other races* It may be doubted whether any character can be named which is distinctive of a race and is constant Savage ev n within the limits of the same tribe are not nearly so uniform in character as has been often asserted Hottentot women offer certain peculiarities more strongly marked than those occurring in any other race but these are known not to be of constant occurrence In the several American tribes colour and hairiness differ considerably as does colour to a certain degree and the shape of the features greatly in the negroes of Africa The shape of the skull varies much in some races [17] and so it is with every other character Now all naturalists have learnt by dearly bought experience how rash it is to attempt to define pecies by the aid of inconstant characters

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independently in many cases as far as we can judge of their having intercrossed Man has been studied more carefully than any other animal and yet there is the greatest possible *diversity amongst capable judges whether he* should be classed as a single species or race or as two (Virey) as three (Jacquinot) as f ur (Kant) five (Blumenbach) ix (Buffon) seven (Hunter) eight (Agassiz) eleven (Pickering) fifteen (Bory de St Vincent) sixteen (Desmoulins) twenty two (Morton) ixty (Crawfurd) or as ixty three according to Burke [8] This diversity of judgment does not prove that the races ought n t to be ranked as specie but it shews that they graduate into each other and that it is hardly pos ible to discover clear di tinctive characters between *them*

Every naturalist who has had the misf r tune to undertake the description of a group of highly varying org nisms has encountered cases (I peak after experience) preci ly like that of man and if of a cautious di po ition he will end by uniting all the forms which graduate into each other under a ingle pe cies for he will say to himself that he has no right to give name *to objects which he cannot* define Cases of this kind occur in the Order which include man namely in certain genera of monkeys whilst in other genera, as in Cercopithecus, mo t of the speci s can be determined with c rtainty In the American gen is Cebus, the various forms are ranked by some natur alists as pecies by others as mere geograph ical races Now if numerous pecimens of

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of man. Ne rth less, t m t be confesseu that th re are f rms, t l ast n th getabl kingd m,[19] which we cann t oid naming as species, b t which are connected tog ther by umbe less gradati ns, ind pend ntly of in tercrossi g.

Som nat ralists ha latel empl yed th t rm sub-pecies to designate f rms whi h possess many f the charact ri tics f true spe cies, b t which hardl deserv so high a rank. N w if w reflect n th w ghty argum nts bo n for raising th races f man to th

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d ne f the large gen g rally in lud closely allied f rms, which can be distinguished nly w th m ch difficult whilst the smaller g n ra within th same family in lud forms that are perfectl dist nct y t all must be ranked eq ally as species. So again, pecies w thin th sam larg g us b no means re semble ach th to th same d gree n th contrar some of th m can g rally be ar ranged in little groups round th pecies, like sat ll tes ro d plan ts.[20]

Th q ti wh th mankind consists of one or se ral sp cies has f late y ars been much discussed by anthropolo ts, wh are d led t th t schools f m nog nists and p l g ni ts. Those ho d not admit th principle of l t n, must look t pecies as separat creations, som mann as distinct tities and th must decid what forms of man they w ll consid as pecies by the anal gy of the m thod commonly p rsued anking othe rganic bei gs as peci s. B t t is hopeless nd our t decid thi point, until som defin ti n of the term species is g n rall accepted and the definiti n must n t include an ind terminate element such as an act f creati n. We might as well tt mpt with t any d finition to decide wheth r a certain number of house should be called a ill ge town, o city W ha e a pract cal illustrati n f th difficulty in th e er-end ing d ubts wh th r many closely-all ed mam mals, birds, insects, and plants, wh ch repre sent ach othe respecti ly in North America and Europe h uld be ranked as pecies r geographical races and th like holds tru of the prod cti ns of many islands situated t som little distance from the nearest con t nt.

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our d mestic animals th qu tion wh th r the ari us races ha arisen from o e o m re specie is som what diff rent. Alth h t may be admitted th t all th races, as well as all the natural species within th sam gen s, ha prung from the same primiti tock, y t t is a fit subject f discussi n, wh th all th d mesti races of th d g, f nstance ha acquired th ir present am unt f diff nce since some pecies was first d mesticated by man wh th r th y owe som of their haracters to nheritance from distinct pecies, which had alread been diff rentiated in tate of nature W th man ch question can arise f h cann t b said to ha e been d m ticated t any particular period.

During an early tag n the di rg ce of th races of man from a common tock, th diff re ces between the races and th n m be must ha e been mall conseq ntly as far as th disti guishi g haract rs are co cerned th y th n had less laim to ank as dist nct peci than the existing so-called races. N rth less, so arb trary th t rm f pecies, that ch arly races w ld pe h p ha been ranked by some naturali ts as distinct pecies, if their diff rences, alth gh trem ly sl ght, had been m re constant than th y are t present, and had n t gradu ted to ach th r

[19] Prof Nägeli has carefully described several striking cases in his *Botanische Mittheil* gen, B n, 1866, ss. 294-369. Prof Asa Gray has made analogous remarks some termediate forms in the Compositae of N America.

[20] *Origin of Species*, this ed., p. 59

[21] See Prof Huxley t this effect in the *Fortnightly Review* 1865, p. 275.

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Our naturalist would likewise be much dis turbed as soon as he perceived that the di tinctive characters of all the race were highly variable This fact strikes every one on first beholding the negro slaves in Brazil who have been imported from all parts of Africa The same remark holds good with the Polynesians and with many otl er races It may be doubted whetl er any character can be named wl ich is distinctive of a race and is constant Sava es even within the limits of the same tribe are not nearly so uniform in character as has been often asserted Hottentot women offer certain peculiarities more strongly marked than those occurring in any other race but these are known not to be of constant occurrence In the several American tribes colour and hairness differ considerably as does colour to a certain degree and the shape of the features greatly in the negroes of Africa The shape of the skull varies much in some races [17] and so it is with every other character Now all naturali ts have learnt by dearly bought experience how rash it is to attempt to define pecies by the aid of inconstant characters

But the most wei hty of all the arguments against treating the races of man as distinct species i that they graduate into each other independently in many cases as far as we can judge of their having intercrossed Man has been studied more carefully than any otl er

as two (Virey) as three (Jacquinot) as four (Kant) five (Blumenbach) ix (Buffon) seven (Hunter) eight (Agassiz) eleven (Pick ering) fifteen (Bory de St Vincent) ixteen (Desmoulins) twenty two (Morton) sixty (Crawfurl) or as sixty three according to Burke [8] This diversity of judgment does not prove that the races ought not to be ranked as specie but it shews that they graduate into each other and that it is hardly possible to discover clear distinctive characters between them

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pp 108-209 227 I l t k som f th bo e tat t f H F ttl s O gi nd l t q ty J *I hys al M n*, Bost 1866 p 35

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arrow heads, bro ght from the most distant parts of the world, and manufactured t the most remote periods, are almost id ntical and this fact can onl be accou ted f r by the arious races ha g similar n nti o mental powers. Th sam observ ti has been mad by archæolo ists[28] with respect t certain wid l pre alent ornam ts, such as zig zags, &c. and with respect t ari us simple belief and customs, ch as th burv g of th dead under megalithic structures. I rem mbe observin in So th America,[29] that there, as in so many oth parts of th w ld, m ha gen rall chosen the summits of loft hills, to throw p pil of to s, th r as record of som remarkabl e nt, f r burying their dead.

N w wh naturalists observ close agreeme t um rous small d tails of hab ts, tastes, and d sposit between t o m re domestic races, between nearl allied natural forms, th use this fact as an argument that the are descended from comm n progenitor who was th nd ed and conse q entl that all sh ld be classed und th sam species. Th sam argum nt may be pplied w th much f rce to th race of man.

As t is mprobabl that th numerous and unimportant points of resemblance between the se ral races of man in bodily stru ture and m tal faculties I d not here ref t similar cu t ms should all ha bee independ tl acquired they must ha e been inh ri ed from pro enit rs who had these same haracters. W thus gain som insight int th arl stat of man, bef re h had pread st p b step the face of th arth. Th spread g of man t regions wid l separated by the sea, no doubt, preceded an great am unt of di ence of haracte in th se ral races for otherwise w should som times meet with the sam race in distinct co tin ts and thus ne the case ir J Lubbock, aft comparing the arts now practised by savages n all parts of the w rld, specifies those which man could n t ha e kn wn, wh n h first wand red from his original birthplace f r if once learnt th y would r h e been forg tten.[30] He thus sh w that the pear which is b t a d v l pment of the knife-point, and the lub which is but a l ng hamm are th nly thin s l ft." He admits, h w r that the art of making fire probably had been already disco ered, f t is comm n to all th races now existing, and was kn wn to th anci nt cave-inhab tants of Europe. P hap th art of making rud canoes o rafts was lik wise kn wn b t as man xisted at rem t poch, wh n the land in many place stood t ry diff rent le l to what t does n w h would ha been bl witho t th aid f canoes, to ha pread w d ly Sir J Lubbock further remarks h w improbabl t is that o earliest ancestors could ha counted as high as ten, consid ring that so many races n w in xistence cann t get beyond f Ne rth l ss, at thi arly period th int llectual and social faculties of man could hardly ha been infer r in any e treme d gree to th se possessed t present by th l we t sa ages otherwise prim al man could n t h e been so mi n ntl successful in th trug l f lif as pro ed by hi arl and wid diffus n.

From th fundam ntal d ff rence between certain languag s, som philol gists ha in f rred that wh n man fi t becam widely diffused, h was n t peaking animal b t it may be uspected that languages, far less perfect than an n w pok n, aided b g tures, might ha been used and y t h v l ft no traces n subsequ nt and m re hi hly-d l oped t u s. W th t th use of som langua e, h w mperfect, it ppears d btful wh th man intellect could ha rise to th standard implied by his d minant positi n at an arl period.

Wh th prim al man, wh n h possessed b t f w arts, and th se f th rudest kind and when his pow f langu was trem ly imperfect, would h dese ed to be called man, mu t d pend n th d finit n which w m ploy In series f f ms graduating insensibly from som pe l k cre t re t man as h n w xists, t w ld be mpossible to fix n any d finit point when th t rm man ght t be used. B t this is m tt of ry littl importance. So again, t is almost a matt of indiff rence wh th th so-called races of man

[28] O Anal ous Forms of Impleme ts, Me ... Anthropological Society by H. M. Westropp. The Pre-historic Phases of Man. ... ed by Sir J Lubbock, 1868, p. 104.
Westropp On cromlechs, &c., Journal of Ethnological Soc., as ... Scien ... Opinion, June 2, 1869, p. 3.

[29] Journal of Researches Voya of the Beagle p. 46.

[30] Prehistoric T mes, 1869 p. 5 4.

It is however possible though far from probable that the early progenitors of man might formerly have diverged much in character until they became more unlike each other than any now existing races but that subsequently as suggested by Vogt[22] they converged in character When man selects the offspring of two distinct species for the same object he sometimes induces a considerable amount of convergence as far as general appearance is concerned This is the case as shown by von Nathusius[23] with the improved breeds of the pig which are descended from two distinct species and in a less marked manner with the improved breeds of cattle A great anatomist Gratiolet maintains that the anthropomorphous apes do not form a natural sub group but that the orang is a highly developed gibbon or Semnopithecus the chimpanzee a highly developed Macacus and the gorilla a highly developed mandrill If this conclusion which rests almost exclusively on brain characters be admitted we should have a case of convergence at least in external characters for the anthropomorphous apes are certainly more like each other in many points than they are to other apes All analogical resemblances as of a whale to a fish may indeed be said to be cases of convergence but this term has never been applied to superficial and adaptive resemblances It would however be extremely rash to attribute to convergence close similarity of character in many points of structure amongst the modified descendants of widely distinct beings The form of a crystal is determined solely by the molecular forces and it is not surprising that dissimilar substances should sometimes assume the same form but with organic beings we should bear in mind that the form of each depends on an infinity of complex relations namely on variations due to causes far too intricate to be followed —on the nature of the variations preserved these depending on the physical conditions and still more on the surrounding organisms which compete with each —and lastly on inheritance (in itself a fluctuating element) from innumerable progenitor all of which have had their forms determined through equally complex relations It appears incredible that the modified descendants of two organisms if these differed *from each other* in a marked manner should ever afterwards converge so closely as to lead to a near approach to identity throughout their whole organisation In the case of the convergent races of pigs above referred to evidence of their descent from two primitive stock is according to von Nathusius still plainly retained in certain bone of their skulls *If the races of man had descended* as is supposed by some naturalists from two or more species which differed from each other as much or nearly as much as does the orang from the gorilla it can hardly be doubted that marked differences in the structure of certain bones would still be discoverable in man as he now exists

Although the existing races of man differ in many respects as in colour hair shape of skull proportions of the body &c yet if their whole structure be taken into consideration they are found to resemble each other closely in a multitude of points Many of these are of so unimportant or of so singular a nature that it is extremely improbable that they should have been independently acquired by aboriginally distinct species or races The same remark holds good with equal or greater force with respect to the numerous points of mental

mind as any three races that can be named yet I was incessantly struck whilst living with the Fuegians on board the *Beagle* with the many little traits of character shewing how similar their minds were to ours and so it was with a full blooded negro with whom I happened once to be intimate

He who will read Mr Tylor s and Sir J Lubbock s interesting works[24] can hardly fail *to be deeply impressed with the close* similarity between the men of all races in tastes, dispositions and habits This is shown by the pleasure which they all take in dancing rude music acting painting tattooing and otherwise decorating themselves in their mutual comprehension of gesture language by the same expression in their features and by the same inarticulate cries when excited by the same emotions This similarity or rather identity is striking when contrasted with the different expressions and cries made by dis-

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10[?] ... 1861 p 119
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[24] Tyl *E ly History f M nk nd*, 1865 with re pect t g ture-l gu g see p L bbock s *P histori T m* 2nd ed 1869

tinct species of m nkeys. Th re is good
h rt f shooting with bows and

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arrow h ads, brought from the most distant parts of th w ld, and man factured t the most rem t periods, are almost identical and this fact can nl be acco ted f r by the arious races ha g similar in nti or m tal pow rs. Th sam observ t has bee mad by archæologists* with respect to certain wid ly pre ale t rnam ts, uch as zig zags, &c. and with respect t ari us simpl beh f and cust ms, uch as th b ry in of th dead under megal thi stru t res. I rem mbe observin in So th Ameri a,[17] that th re, as so many th parts f th w ld, m ha g rall chosen th ummits of loft hills, t throw p piles of t n s, th as record of som remarkabl t, or for burying their d ad.

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*O Analogous Forms of Impleme ts. M moi of Anthropological Society by H. M. Westropp. The Primitive Inhabitants of Scandinavia, Eng. translat edited by ir J Lubbock, 1868, p. 104

Westropp On Cromlechs, &c., Journal of Ethnological Soc as gi in Scient fic Op ion, June 2, 1869, p. 3.

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It is however possible though far from probable that the early progenitors of man might formerly have diverged much in character until they became more unlike each other than any now existing races but that subsequently as suggested by Vogt [22] they converged in character When man selects the offspring of two distinct species for the same object, he sometimes induces a considerable amount of convergence as far as general appearance is concerned This is the case as shown by von Nathusius [23] with the improved breeds of the pig which are descended from two distinct species and in a less marked manner with the improved breeds of cattle A great anatomist, Gratiolet maintains that the anthropomorphous apes do not form a natural sub group but that the orang is a highly developed gibbon or Semnopithecus the chimpanzee a highly developed Macacus and the gorilla a highly developed mandrill If this conclusion which rests almost exclusively on brain characters be admitted we should have a case of convergence at least in external characters for the anthropomorphous apes are certainly more like each other in many points than they are to other apes All analogical resemblances as of a whale to a fish may indeed be said to be ca of

... ney rash to attrib it to convergence ... ny points of ... cendants of ... a crystal is ... n olecular forces and it is not surprising that dissimilar substances should sometimes assume the same form but with organic beings we should bear in mind that the form of each depends on an infinity of complex relations namely on variations due to causes far too intricate to be followed —on the nature of the variations preserved these depending on the physical conditions and still more on the surrounding organisms which compete with each —an l l tl n inherit ... f om in ... iave had ... equally complex relations It appears incredible that the modified descendants of two organisms if these differed from each other in a marked manner should ever afterwards converge so closely as to lead to a near approach to identity throughout their whole organisation. In the case of the convergent races of pigs above referred to evidence of their descent from two primitive stock is according to von Nathusius still plainly retained in certain bones of their skulls If the races of man had descended as is supposed by some naturalists from two or more species which differed from each other as much or nearly as much as does the orang from the gorilla it can hardly be doubted that marked differences in the structure of certain bones would still be discoverable in man as he now exists

Although the existing races of man differ in many respects as in colour hair shape of skull proportions of the body &c yet if their whole structure be taken into consideration they are found to resemble each other closely in a multitude of points Many of these are of so unimportant or of so singular a nature that it is extremely improbable that they should have been independently acquired by aboriginally distinct species or races The same remark holds good with equal or greater force with respect to the numerous points of mental similarity between the most distinct races of man The American aborigines Negroes and Europeans are as different from each other in mind as any three races that can be named yet I was incessantly struck whilst living with the Fuegians on board the *Beagle* with the many little traits of ch ... hewing how ... nd so it was ... om I hap-

He who will read Mr Tylor s and Sir J Lubbock s interesting works[24] can hardly fail

... pleasure which they all take in dancing rude music acting painting tattooing and otherwise decorating them elve in their mutual comprehension of gesture langu ge by the same expre ion in their features and by the same inarticulate crie when excited by the same emotions This ... milarity or rather identity is striking when contrasted with the different expr ssions and cri s ma l by dis-

[22] W th respect to c ttl se M d Q atref g U ité de l Espece H m ne 1861 p 119

[24] Tyl s E ly H st y f M k nd, 1865 w th re pe t t g t re la gu g see p ... Lubbock s Pr h to T m 2nd ed 1869

wh a weak tribe i not thus bruptly swept w y f it nce b gins to decrease, it g erally goes o decreas ng u til t becomes ext t.[22]

Wh civilised nati ns com into co tact with barbarians th truggl sh rt, except h re deadly l m te gi it ai l t the nati race Of the se wl l l ad t the vict ry f ci lised t ns, som are plain and simple, th rs complex and bscu W can see that th cult ti n f th land w ll be f tal in many way to sav g s, f th y can n t, will n t, change th h t ts. N w diseases and ha som ase pro ed highly destru ti and t ppears that n w disease fte cause m h d th, til those h are most scept bl t ts d t ti fl ce re grad lly weeded t [23] and so it m y b with th l ffects f m p nt us l q rs, as ll as with th unco q ably tr g tast f th m sh wn by so many sa ages. It furth ppears, my teri us as the fact that the first meeting f d tinct and sep rated peopl g t disease [24] M pr t wh in Vanco I lan l losel t te ded t th ubject f ti ti n, bel ed that changed hab ts f lif conseq t th ad t f Europeans, i ce m h ll h alth

th y l se th m t f rti n, and get w th ir place. [25]

Th grad f th ci l sati seems to be a m t mpo tant l m t in th s ccess f com peti g t ns A f w ce turi g Europe feared th nroads f East rn barbarians w any ch f ar w uld be ridiculous. It is m re uri us fact, as M B h t has remarked that s. ages did n t f rm ly wast w b f re th lassical t ns, as th y w d bef re mod rn lised nat ns had th y d so th ld m alist w ld ha mused th t b t th re is lam t in any write f that period th pe ishin barbarians.[26]

Th m t ri t t f all th c uses f e tinct n, be i juri us th msel s. I am mu h in d bt d t Mr H H H w rth f r l all d n y attent to th is bject, and f r l n g gi n uf m t re ect g it. H e col lected th e f ll g ases.

Wh n Tasmani was f t colon se l the n t re n lly timated by some t 000 and by th rs at 20 000 Their n mber was soo g tl redu ed l fly by fight g w th th e E gl h and w th ach th Aft r th f m us l t by all the col ts, wl th e remai g nat s l l red th msel es p to th g rnm t, th y consi t d only of 120 d duals,[27] wl w re n 1832 tran ported to Flind rs I lan l This island sit ted between Tasmania and Australia, is f rty m l s l , and from tw l t e ght en m le broad it seems h lthy and th nati es w w ll tre ted N rth less, th y ff ed gre tly n h alth. In 1834 th y consi ted (Bon ck, p 2 0) of f ty se n ad lt m les, forty-e ght adult f mal s, and ixteen hildren, or in all f 111 so ls. I 1835 ly ne hundred were left. As th y co ti ed rap dly t decrease and as th y th msel es th ght th t th y sh ld t per h so quickly lse h re th y w re rem ed n 1847 to Oy t r Co e in the so thern part f Tasmania. Th y th n con ted (Dec. 0th, 184) of f urteen m n, tw nty tw w m n and t n l ldren.[28] But th chan f sit did n good D sease and d th till p rsued th m, and n 1864 ne man (wh d ed n 1869) and th ee ld ly w m lo e ur ed Th nf rtility f the w m s n a m remarkable fact than th liab l ty f all to ill h alth and death. At th tim wh nly ni e w men w l ft t Oy te Co th y told Mr Bo w ck (p 386) th t nly tw had borne hildre and these t had tog ther produced nly three child

W th re pect to the se f th traordinary tat f th gs, D ... tory r marks th t d th f ll wed th att mpts to ci l se th n ti es. If l ft t th msel t roam as th y w re t and d turbed th y w uld h e

[22] Gerland ibid. s. 12, gi es f cts pport f this ... ne e p 435) good ma y cases bearing this subject see also Gerla d, ibid. S. Poepp g speaks f the breath of ci ilisatio as poiso us to sa es.

[23] Sproat, Scene nd Studies f S vag L f 1868 p. 284

Bageh t, Phy cs d P litics, Fort ghtly Re view April 1, 1868, p 455

are thus designated, or are ranked as species or sub-species; but the latter term appears the more appropriate. Finally, we may conclude that when the principle of evolution is generally accepted, as it surely will be before long, the dispute between the monogenists and the polygenists will die a silent and unobserved death.

One other question ought not to be passed over without notice, namely, whether, as is sometimes assumed, each sub-species or race of man has sprung from a single pair of progenitors. With our domestic animals a new race can readily be formed by carefully matching the varying offspring from a single pair, or even from a single individual possessing some new character; but most of our races have been formed, not intentionally from a selected pair, but unconsciously by the preservation of many individuals which have varied, however slightly, in some useful or desired manner. If in one country stronger and heavier horses, and in another country lighter and fleeter ones, were habitually preferred, we may feel sure that two distinct sub-breeds would be produced in the course of time, without any one pair having been separated and bred from, in either country. Many races have been thus formed, and their manner of formation is closely analogous to that of natural species. We know, also, that the horses taken to the Falkland Islands have, during successive generations, become smaller and weaker, whilst those which have run wild on the Pampas have acquired larger and coarser heads; and such changes are manifestly due, not to any one pair, but to all the individuals having been subjected to the same conditions, aided, perhaps, by the principle of reversion. The new sub-breeds in such cases are not descended from any single pair, but from many individuals which have varied in different degrees, but in the same general manner; and we may conclude that the races of man have been *similarly* produced, the modifications being either the direct result of exposure to different conditions, or the indirect result of some form of selection. But to this latter subject we shall presently return.

On the Extinction of the Races of Man.—The partial or complete extinction of many races and sub-races of man is historically known. Humboldt saw in South America a parrot which was the sole living creature that could speak a word of the language of a lost tribe. Ancient monuments and stone implements found in all parts of the world, about which no tradition has been preserved by the present inhabitants, *indicate much extinction.* Some small and broken tribes, remnants of former races, still survive in isolated and generally mountainous districts. In Europe the ancient races were all, according to Shaaffhausen,[19] "lower in the scale than the rudest living savages;" they must therefore have differed to a certain extent from any existing race. The remains described by Professor Broca from Les Eyzies, though they unfortunately appear to have belonged to a single family, indicate a race with a most singular combination of low or simious and of high characteristics. This race is "entirely different from any other, ancient or modern, that we have heard of."[20] It differed, therefore, from the quaternary race of the caverns of Belgium.

Man can long resist conditions which appear extremely unfavourable for his existence.[21] He has long lived in the extreme regions of the North, with no wood for his canoes or implements, and with only blubber as fuel

worthy to be called a hovel. In South Africa the aborigines wander over arid plains where dangerous beasts abound. Man can withstand the deadly influence of the Terai at the foot of the Himalaya, and the pestilential shores of tropical Africa.

Extinction follows chiefly from the competi

especially lessened fertility. If any one of these checks increases in power, even slightly, the tribe thus affected tends to decrease; and when of two adjoining tribes one becomes less numerous and less powerful than the other, the contest is soon settled by war, slaughter, cannibalism, slavery, and absorption. Even

[19] Translation in *Anthropological Review*, Oct. 1868, p. 431.

[21] Dr. Gerland, *Über das Aussterben der Naturvölker*, 1868, s. 82.

Year	Native Population (Except during 1832 and 1836, when the few foreigners in the islands were included.)	Annual rate of decrease per cent, according to ... between the successive censuses; these censuses being taken at irregular intervals.
1832	130,313	
		4 46
1836	108,579	
		2 4
1853	1 019	
		0 81
1860	67 084	
		2 18
1866	58, 65	
		2 17
1872	51,531	

W h re see that th t rval of f rty

q red tribe and to n wly introduced diseases, which ha been se ral occasi ns e trem ly destructi e. No d bt tl ese and th ch ca ses h been highl ffi nt, and may account f th xtraordinary rat of decrease betwe th years 183 and 1856 b t the mo t pot t of all th cause seem t be lesse ed f rtility According t D Rusch n ber of th U S. N vy wh isited these sland betwee 1835 and 183 in dis-trict of Hawaii, nl tw t fi m out of 1134 and in anoth distri t nly t n o t of 65 had famil with as man as three children. Of eight married w m n, nly thirt m had born children and th fficial report gi es an rag f half child to each married co pl in th wh l sland. This almost xactly th sam rage as with th Tasmanians t O t Co Jarves, who p b shed his *H t ry* in 1843 sa that families who have three children are freed from all taxes those ha in more are re warded b gifts f land and th nco rage-m ts. This parall led nactm t by th g rnm t w ll sh w h w *inf rtil* th race had becom Th R A. B sh p tated th H waiian *Spectat* in 1839 th t larg propor of th hildre di at arly ges, and Bishop Stale inf rms m that this is till th case j st as in N w Zealand Thi has bee ttrib ted t th n glect f th childre b th w m n, b t t is probably large part d t innate w akness of const tuti n n tl e chil dren, relat t th l ssened f rt l ty of th i pare ts. Th re is, moreo r a furth r resemblance to th case of New Zealand in th fact that th re is a large xcess of male r f mal births th c nsu of 18 2 gi es 31 650 males t 5 f males f all ages, tl at is 125.36 males f r ry 100 females wh reas n all ci l sed co tries the f males xceed the males. N d bt th profligacy of tl w m n m y n part acco t f r tl r mall f rtilit b t th hanged hab ts of lif is much more probable cause and which w ll at the same tim acco t f the increased mortalit es-peciall of th ch ldren. The island w re isited l Cook 1779 by Vancou r 1 94 and oft n bseq tl by whalers. In 1819 missi nari arri ed, and f nd that id latry had been alread aboli l ed and oth r hang s ffected b the ki g. Aft r this period tl ere was *rapid* hang n almo t all th hab t of lif of th nat s, and tl y soo becam tl most ci l sed of th Pacific I land rs. O of my nformants, Mr Coan, wl o was born th islands, remarks that th nati es l un d rg great hange i tl ir hab ts of life in th co rse of fift ears than Englishm n d n a tho sand y ars. From i f rmation rece ed from Bish p Stal y t doe not ppear that th poore lasse ha r m h changed th d t, altho gh many ew kinds of fru t ha e bee troduced, and th gar-can is in uni rsal use O g, h w t th i passi n f imitat g E ropeans, th alt red th r man of dress g t an arly period, and tl use of alcoholic drinks becam ry g n ral. Alth gh these hange i pear consid able I can w ll bel from what is kn wn with re pect to an mals, that th y m ght ffice t lesse the f rtil t of th nati es.[a]

Lastl M Macnamara t t " th t tl l w and d graded inhab tants of tl Andaman Islands, n th ast rn id of tl e Gulf of Bengal, are min ntly uscept bl t an hange

[a] The f regoi g stat me t are take hiefly from the f llo g w rks J rr *History of the H wa ia Isl nds* 1843, pp. 400-407 Cheever *Li in the Sandw h Islands*, 1851 p. 277 Rusche berger is quoted b Bo ick, *Last f the Tasm ians* 18 0 p. 3 8. Bishop is quoted by Sir E. Belch *V yag Ro nd th W orld*, 1843, ol i., p. 272. I w the census of the several years t the ki dness of M Coan, t the request of D N umans of New York d most cases I ha e compared the N umans figures th those gi e se eral of the bo e-named works. I ha mitted the census for 1850 as I ha e see tw idel differe t umbers gi n.

[b] *The Indian Medical Gazette* N 1 1871 p. 240.

reared more children and there would have been less mortality Another careful observer of the natives Mr Davis remarks The births have been few and the deaths numerous This may have been in a great measure owing to their change of living and food but more so to their banishment from the mainland of Van Diemen s Land and consequent depression of spirits (Bonwick pp 388 390)

Similar facts have been observed in two widely different parts of Australia The celebrated explorer Mr Gregory told Mr Bonwick that in Queensland the want of reproduction was being already felt with the blacks even in the most recently settled parts and that decay would set in Of thirteen aborigines from Shark s Bay who visited Murchison River twelve died of consumption within three months [39]

The decrease of the Maories of New Zealand has been carefully investigated by Mr Fenton in an admirable report from which all the following statements with one exception are taken [40] The decrease in number since 1830 is admitted by every one, including the natives themselves and is still steadily progre sing Although it has hitherto been found impossible to take an actual census of the natives their numbers were carefully estimated by residents in many districts The result seems trustworthy and shows that during the fourteen years previous to 18 8 the decrease was 19 42 per cent Some of the tribes thus carefully examined lived above a hundred miles apart some on the coast some inland and their means of sul [illegible]

[illegible] another census was taken and the number i given as only 36 3 9 shewing a decrease of 3 [illegible] per cent [1] Mr Fenton after shewing in detail the insufficiency of the various cause usually assigned in explanation of this extraordinary decrease such as new diseases the profl [illegible] ars &c [illegible] de pend [illegible] the women and on the extraordinary mortality of the young children (pp 31 34) In proof of this he shews (p 33) that in 1844 there was one non adult for every [illegible] 57 adults whereas in 1858 there was only one non adult for every 3 27 adults The mortality of the adults is also great He adduces as a further cau e of the decrease the inequality of the sexes for fewer females are born than males To this latter point depending perhaps on a widely distinct cause I shall return in a future chapter Mr Fenton contrasts with astonishment the decrease in New Zealand with the increase in Ireland countries not very dissimilar in climate and where the inhabitants now follow nearly similar habits The Maories themselves (p 35) attribute their decadence in some measure to the introduction of new food and clothing and the attendant change of habits and it will be seen when we consider the influence of changed conditions on fertility that they are probably right The diminution began between the years 1830 and 1840 and Mr Fenton shews (p 40) that about 1830 the art of manufacturing putrid corn (maize) by long steeping in water was discovered and largely practised and this proves that a change of habits was beginning among the natives even when New Zealand was only thinly inhabited by Europeans When I visited the Bay of Islands in 183 the dress and food of the inhabitants had already been much modified they raised potatoe maize and other agricultural produce and exchanged them for English manufactured goods and tobacco

It is evident from many statements in the life of Bishop Patteson [2] that the Melane ians of the New Hebrides and neighbouring archipelagoes suffered to an extraordinary degree in health and perished in large numbers when they were removed to New Zealand Norfolk Island and other salubrious places in order to be educated as missiona ies

The decrease of the native population of the Sandwich Islands is as notorious as that of New Zealand It has be n roughly e timated by those best capable of judging that when Cook discovered the island in 1 9 the population amounted to about 300 000 According to a loose census in 18 3 the numbers then were 14 0 0 In 183 and at several subsequent periods an accurate cer sus was officially taken but I have been able to obtain only the following returns

New Z l nd by Alex K [illegible] dy 18 3 p 47

[illegible] *L f f J C P tteso* by C M Young 18 4 see m re e p c lly [illegible] p 530

not qu free in their nati e coun ry me er in others thus circumstanced frequently bat ne er produce of peing th rs again produce some of pring but f w than in a state of nature and as bearing on the abo e cases I may t important to remark that the young are pt to be w ak and sick or malformed, and to perish at an early age

Seeing how general is this law of the suscep tibility of the reproducti st m t changed conditions of l and that t holds good w th ur nearest allies th Quadrumana, I can hardly doubt that t pplies to man in his primi al stat Hence if sa ages f any race are induced suddenly t change their habits of lf the become more less st rile and their ung offspring suff n h alth, in t same manne and from the sam ause as do the lephant and hunting leopard in India, many monk s in America, and host of animals f all kinds, on remo al from their natural condition

W can see wh t is that aborigines, who have long inhab ted islands, and who must ha been long osed t n arly uniform conditions, should be pecially affected b an hange in their habits, as seems to be the case Civilised races can certainly resist hanges of all kinds far bett than sa ages and in this respect the resemble d mestic ed animals, for though the latt r sometimes suff in health f instance European dogs in India) t th are rarely rendered st rile though a f w such instances ha been recorded. The immunit f ci ised races and domesticated animals is probabl d t their ha ing been subjected t re t t nt, and theref re ha ing gro n som hat more accust med, to di ersified r arying conditions, than the majority of wild animals and to their ha ing formerl immigra ed or bee arried from count t country and t d d n t famili e sub ces ha ing in rcrossed. It ppe rs that a cross w th ci ilised races t nce gi es to an aboriginal race an immunit from the l consequences f hanged conditions. Thus t ossed offspring from th Tahitians and Eng lish, he settled in Pitcairn I land, increased so rapidl that th island was soon o s ked and in June 185 the w re remo ed t Norf lk Island. The the consisted of 60 married persons and 134 hildren, making a t tal of 194 H re th lik wise increased so rapidly that althou h s xt e of them re turned to Pit airn I and in 1859 th num bered in January 1868 300 souls the males and f males being in exactly equal numbers. What a contrast does this case present w h that of the Tasmanians the Norfolk Island rs increased in on tw l e and a half ars from 194 to 300 whereas the Tasmanians decreased during fifteen ars from 120 to 46 of which latt r numbe onl t n w re children.*

So again in the int rval between th census of 1866 and 1872 th nati es of full blood in the Sandwich Islands decreased b 8081 whilst the half-castes, who are belie ed to be h al hi r increased b but I do not know wh th r the latt numb er includes the off spring from the half-castes, or onl the half astes f t first generation.

Th cases which I ha e here g n al relate t w nes, who ha been subjected to w f

pelled b an use such as t e invad f a conqu ring t be t desert their hom and t change th ir hab ts. It is an n resting circumstance that the h f hec to wild animals becoming d mesticated, which ensures the pow of their breeding freely wh n first c ptured, and one chief check to ci il men, wh n brought into contact w th ci ilisation, ri ing to f rm a ci ised race is the sam namel st rilit from hanged conditions of lif

Finall although the gradual decrease and ultimate tinction of the races f man is a highl ompl x problem d pending n many causes which dif in diff rent places and t different times t is the same problem as th t presen ed b the tinction f on f the high animal — f t e f ssil horse f r in stance which has peared from South Ameri ca, soon aft rwards t be replaced, thin the same districts, b ountless troops f the Spanish h rse The N w Zealand r seems con scious of this parallelism, for he om ares his f ture fate w th that f the nati e rat now almost t rminated b th European t. Though the difficult is gre t to our imagina tion, and reall, re t if w wish to asce tain th precise auses and th ir manner f action, t ough t not t be so t our reason, as long as keep t adil in mind that the increase f

Variation f Animal &c ol ii, p 16

*These details are tak from The Mutineer f the Bounty, b Lady Belcher 1870 nd from Pit cairn Island, ordered t be prin ed b the House f Commons, M 1863. The foll ing stateme ts about the Sandwich Islanders are from the Honolulu Gazette and from Mr C an.

of climate in fact take them away from their island homes and they are almost certain to die and that independently of diet or extraneous influences He further states that the inhabitants of the Valley of Nepal which is extremely hot in summer and also the various hill tribes of India suffer from dysentery and fever when on the plains and they die if they attempt to pass the whole year there.

We thus see that many of the wilder races of man are apt to suffer much in health when subjected to changed conditions or habits of life and not exclusively from being transported to a new climate Mere alterations in habits which do not appear injurious in themselves seem to have this same effect and in several cases the children are particularly liable to suffer It has often been said as Mr Macnamara remarks that man can resist with impunity the greatest diversities of climate and other changes but this is true only of the civilised races Man in his wild condition seems to be in this respect almost as susceptible as his nearest allies the anthropoid apes, which have never yet survived long when removed from their native country

Lessened fertility from changed conditions, as in the case of the Tasmanian [illegible]

[illegible] of every population would sooner or later lead to extinction The diminution of fertility may be explained in some cases by the profligacy of the women (as until lately with the Tahitians) but Mr Fenton has shewn that this explanation by no means suffices with the New Zealanders nor does it with the Tasmanians

In the paper above quoted Mr Macnamara gives reasons for believing that the inhabitants of districts subject to malaria are apt to be sterile but this cannot apply in several of the above cases Some writers have suggested that the aborigines of islands have suffered in fertility and health from long continued interbreeding but in the above cases infertility has coincided too closely with the arrival of Europeans for us to admit this explanation Nor have we at present any reason to believe that man is highly sensitive to the evil effects of interbreeding especially in areas so large as New Zealand and the Sandwich archipelago with its diversified stations. On the contrary it is known that the present inhabitants of Norfolk Island are nearly all cousins or relations, as are the Todas in India, and the inhabitants of some of the Western Islands of Scotland and yet they seem not to have suffered in fertility [illegible]

A much more probable view is suggested by the analogy of the lower animals The reproductive system can be shewn to be susceptible to an extraordinary degree (though why we know not) to changed conditions of life and this susceptibility leads both to beneficial and to evil results. A large collection of facts on this subject is given in chap xviii of vol ii of my *Variation of Animals and Plants under Domestication* [illegible] can here give only the briefest abstract and every one interested in the subject may consult the above work Very slight changes increase the health vigour and fertility of most or all organic beings, whilst other changes are known to render a large number of animals sterile One of the most familiar cases is that of tamed elephants not breeding in India though they often breed in Ava, where the females are allowed to roam about the forests to some extent, and are thus placed under more natural conditions. The case of various American monkeys both sexes of which have been kept for many years together in their own countries, and yet have very rarely or never bred is a more apposite instance because of their relationship to man It is remarkable how slight a change in the conditions often induces sterility in a wild animal when captured and this is the more strange as all our domesticated animals have become more fertile than they were in a state of nature and some of them can resist the most unnatural conditions with undiminished fertility [illegible] Certain groups of animals are much more liable than others to be affected by captivity and generally all the species of the same group are affected in the same manner But sometimes a single species in a group is rendered sterile whilst the others are not so or the other hand a single species may retain its fertility whilst most of the others fail to breed The males and females of some species when confined or when allowed to live almost [illegible]

[illegible]

[illegible] *mals* &c. vol. [illegible] p 111

quit f ce in th ir n t s co try n r
thers thus circum tanced f q tly
b t n produce ffspri g oth rs again
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ur are t all s, tl Q ad umana, I can hardly d bt that t pt l t ma n his prim al tate. H ce f sa g s f y ace are d ced dd nly t l ang tl r hab ts of lif th y becom m re l ss t ril and the r y g ff pri uffe ı h alth ın tl sam m d from th sam c use as d the

al kinds,

ti ns.

W c see why t ı th t ab rigı es, wl l

m nt f ci ilised aces and d m t ted m l prob bly d to th h ı g been bject d t gre t t t, and therefo h g som l t m re accu t med to d rs fied rs g co dit ns, tl an th m y rit f ld animals and to th ha f m l mmig ted b ca ried from co t y t country and t d ff t famil b-ace h ıng ınte -crossed. It ppe rs th t ss w th ci l sed ace t ce gı to an borıgı al ace an mm nıty from th l co seq ce f h ged co l t Th th rossed ff pri g from tl Tah tians and E g l d wl settled P t ai I land ıı ased so pidly that th island was soo tocked d n Jun 1856 tl re rem ed t N rf lk Island Tl th consi ted f 60 arried perso ıs and 134 ch ld making t tal f 194 H re th y lik se ased so p l th t alth gh si tce f th m r t ed to I tcairn I land ın 18 9 tl y num bered ın January 1868, 300 so ls the males f m les be ng ın exactly equal n mb rs.

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the ha
r ı creased by 84 b t I d n t kn w t t tt n mber ı l d s tl e off

t aborıg s, who ha e been *subjected t* ew cond ti ns as th re lt f the ımm grat n of ci l sed men. B t t ril ty and ıll l altl wo ld prob bly f ll w if sa g w re com pelled by any cause h as the road of a co q ring tribe t desert th r h m a l to change th hab ts. It ıs an t re t g cir cumstance th t tl e cl *f check to w ld an mals* becom g d m ticated which ım l es tl e pow f th r breed g freely wl ı first p-tured a d l f cl eck to w ld m n, wh n brought t co tact w th ci l sat n, r ı g to f rm ci il sed race ı tl e same am ly t rility from changed cond tions f *life*

Finally alth gh tl e gradual decrease and ltimat ti cti n f the race f man a highly compl probl m d pend g n m y causes whı h d ffe ın diff rent places and at d ff re t t mes t tl sam problem as th t pres ted by tl e e t t of f tl l gh an mal — f th f s. l l rse for tance, wh ch l sappear d from South Am ca, soo aft ard to be replaced w th th sam d tri ts, by countl ss tro p f tl e Span h h rse Th N w Ze land seems co sci f th parall l m f he compares his f t re f te w th th t f the n ti rat now alm t t m nated by th E ropean t Tl gh th d fficulty s gr t to ım gi ti n, and really re t, if w wish to asc ta n th prec se se and th man of act on, t ght n t t b so to r r aso as l g as k p t addly ın mı d th t the ın ase f

I ration f A mal d l L, p. 16

*These d ta ls are take f m *Th Mut neer f the Bo ty* by Lady B l her 18 0 d from *Pit-rn Island* rd red t b pri ted by th H use f C mm ns, M y 29 1863 Th f ll g tatem ts bo t th S d ch Isla der re from th *H nolul Gazette* d f m M C an.

each species and each race is constantly checked in various ways so that if any new check even a slight one be superadded the race will surely decrease in number and decreasing numbers will sooner or later lead to extinction the end in most cases being promptly determined by the inroads of conquering tribes

On the Formation of the Races of Man —In some cases the crossing of distinct races has led to the formation of a new race The singu lar fact that the Europeans and Hindoos who belong to the same Aryan stock and speak a language fundamentally the same differ widely in appearance whilst Europeans differ but little from Jews who belong to the Se mitic stock and speak quite another language has been accounted for by Broca [49] through certain Aryan branches having been largely crossed by indigenous tribes during their wide diffusion When two races in close contact cross the first result is a heterogeneous mix

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from the black squat tribes of the mountains to the tall olive coloured Brahman with his intellectual brow calm eyes and high but narrow head so that it is necessary in courts of justice to ask the witnesses whether they are Santalis or Hindoos [50] Whether a heterogene ous people such as the inhabitants of some of the Polynesian islands formed by the crossing of two distinct races with few or no pure mem bers left would ever become homogeneous is not known from direct evidence But as with our domesticated animals a cross breed can certainly be fixed and made uniform by careful selection[51] in the course of a few generations we may infer that the free inter crossing of a heterogeneous mixture during a long descent would supply the place of selection and over come any tendency to reversion so that the crossed race would ultimately become homo-geneous though it might not partake in an equal degree of the characters of the two par ent races

Of all the differences between the races of man the colour of the skin is the most con spicuous and one of the best marked It was formerly thought that differences of this kind could be accounted for by long exposure to different climates but Pallas first shewed that this is not tenable and he has since been fol lowed by almost all anthropologists [52] This view has been rejected chiefly because the dis-tribution of the variously coloured races, most of whom have long inhabited their present homes does not coincide with corre ponding differences of climate Some little weight may be given to such cases as that of the Dutch families who as we hear on excellent author ity [53] have not undergone the least change of colour after residing for three centuries in South Africa An argument on the same side may likewise be drawn from the uniform ap-pearance in various parts of the world of gip sies and Jews though the uniformity of the latter has been somewhat exaggerated [54] A very damp or a very dry atmosphere has been supposed to be more influential in modifying the colour of the skin than mere heat but as D Orbigny in South America and Livingstone in Africa arrived at diametrically opposite conclusions with respect to dampness and dry ness any conclusion on this head must be con sidered as very doubtful [55]

Various facts which I have given el ewhere prove that the colour of the skin and hair is sometimes correlated in a surprising manner with a complete immunity from the action of certain vegetable poisons and from the at tacks of certain parasites Hence it occurred to me that negroes and other dark races might have acquired their dark tints by the darker individuals escaping from the deadly influence of the miasma of their native countries during a long series of generations

I afterwards found that this same idea had long ago occurred to Dr Wells [56] It has long been known that negroes and even mulattoes, are almost completely exempt from the yellow

[49] On Anthropology tr nslat o Anth opol g ical Revi w Jan 1868 p 38

[50] Th 1 im I f R al Bengal, 1868 p 134

[51] *The V ri t n f A mals and Pl nts und Domestication*, v l. ii. p. 95

p

th d i c g e by God *De l'Espèce* 1859 v l i p 246 &

[53] S r A d w Smith as qu t d by K ox *Rac s f M* 1850 p 473

[54] See D Qu tr f g th s l d *Revu de Co rs Sci nt fiqu* Oct. 17 1868 p 731

[55] Li ng ton *T l d R he S Africa* 1857 pp 338 339 D Orb g y quoted by Godro

col f ted w th co t t al pecul t s re g y I f f mal nd Pl nt u der Dom tical I i p 22 33

destructi in tropical America.[17]

and pecu
the result f acclimatisation I chief t t s th t th negro regim ts recruited ear tl e So dan, and bo ro ed f m th \ ce y f Egypt f th M xican war esc ped th y l l w f er alm t equally with tl groes ginally bro ght f m ar ou parts of Africa and accustomed t th chmat of the W t In dies That acclimatisati n play part, s sh wn by th many ase in which n groe h becom som l t l able t t p cal

th d th rate f th mm g ants was propo t al to th lat t d f th co try wh ce th y had come. W th th n gro tl mm nity as far as t is th ult f accl m t sat n, m ph po ure dur g p od g s l gth f tim f th borign f trop al Am ri h ha res ded th from tim immem rial are t xempt from y ll f and th R H. B T istram t t th t th re ar dis tri ts rth rn Afri wh h th t nh b tants are compell d ann ally t l th gh th groe can remain w th saf ty Th t th mm t f th g is in any d gree co related w th th ol f h kin is m re co jecture t m y be co related w th som diff re ce in his blood rv y t m, th tiss es N rth less, from th facts bo all ded to and from som connect pp tly xisting b t compl xi and t d cy to consumpt tl co ject se med to m not improb bl C nseq tly I

See f insta N tt and Glidd Type f M kind p 68

M j Tulloch in paper read bef re th Stat s t cal Society Ap il 20 1840 and g th Athenæum 1840 p 3.3

Th Pl ality f the H ma Rac (translat.) 1864 p 60

[17]Quatrefages, U ité de l'E pèc H m ne 1861 p 205 Waitz, I t oduct to Anthr pology tra s lat. I l, 1863 p 124 Li gsto gi es nalogous cases in his T ls

I ured witl l t l ttle uccess,[n] t ascer

and au
mann r Wh n he first arri ed as a boy n tl e 11 l perie ced t gro h f g re-

I the p g of 1862 I bt ed perm ssi from tl D rect G ral f th Medical d partm t f th Army t tr m t t th urgeo f th us gin ts for g service bla k tabl th the f ll g ppe d d rema ks, b t I ha rece ed tur \ se l w ll marked cases ha bee recorded th ur d mestic mals f relatio be t e th col ur of tl d mal ppe d ges d the const t tio d t be g t ous that th re is som l ted d gree of relat bet ee th colour of th races f ma d the limat hab ted l y them the f ll w g estig tio seems rth co d rat n. N m ly h th th re is y relat Europe ns bet ee th colour of thei hair d thei li bility t th diseases of tr p l co tries. If th urgeons of the se eral reg m ts, h tat ed healthy tropical dist cts, ld be so good as first t co t, as ta dard of comp riso h w ma y m th f ree h ce th k re d h l k nd l l t-cl red l l h d t

som th us d cases h d bee t bulated h the

hab ti g f m rem t peri d h lthy trop cal limat m ght ha becom dark-coloured by th bett p serv t f dark hai ed d k compl ed d iduals duri g l g ccess of

ess rom isease f trop al countr es tha persons th dark hair d sall w complexions and so far as I kn w ther p-

fore as these slight indications go there seems no foundation for the hypothesis that blackness has resulted from the darker and darker individuals having survived better during long exposure to fever generating miasma

Dr Sharpe remarks [63] that a tropical sun which burns and blisters a white skin does not injure a black one at all and as he adds this *is not due to habit in the individual for children only six or eight months old are often* carried about naked and are not affected I have been assured by a medical man that some years ago during each summer but not during the winter his hands became marked with light brown patches like although larger than freckles and that these patches were never affected by sun burning whilst the white parts of his skin have on several occasions been *much inflamed and blistered With the lower* animals there is also a constitutional difference in liability to the action of the sun between those parts of the skin clothed with white hair and other parts [64] Whether the saving of the skin from being thus burnt is of sufficient importance to account for a dark tint having been gradually acquired by man through natural selection I am unable to judge If it be so we *should have to assume that the natives of tropi*cal America have lived there for a much shorter time than the Negroes in Africa or the Papuans in the southern parts of the Malay archipelago just as the lighter coloured Hindoos have resided in India for a shorter time than the darker aborigines of the central and southern parts of the peninsula

Although with our present knowledge we cannot account for the differences of colour in the races of man through any advantage thus gained or from the direct action of climate

We have seen in the second chapter that the conditions of life affect the development of the bodily frame in a direct manner and that the effects are transmitted Thus as is generally admitted the European settlers in the United States undergo a slight but extraordinary rapid change of appearance Their bodies and limbs become elongated and I hear from Col Bernys that during the late war in the United States, *good evidence was afforded of this fact by the* ridiculous appearance presented by the German regiments when dressed in ready made clothes manufactured for the American market and which were much too long for the men in every way There is, also a considerable body of evidence shewing that in the Southern States the house slaves of the third generation present a markedly different appearance from *the field slaves* [65]

If however we look to the races of man as distributed over the world we must infer that their characteristic differences cannot be accounted for by the direct action of different conditions of life even after exposure to them for an enormous period of time The Esquimaux live exclusively on animal food they are clothed in thick fur and are exposed to intense *cold and to prolonged darkness* yet they do not differ in any extreme degree from the inhabitants of southern China who live entirely on vegetable food and are exposed almost naked to a hot glaring climate The unclothed Fuegians live on the marine productions of their inhospitable shores the Botocudos of Brazil wander about the hot forests of the interior and live chiefly on vegetable productions yet these tribes resemble each other so closely that the Fuegians on board the Beagle were mistaken by some Brazilians for Botocudos. The Botocudos again as well as the other inhabitants of tropical America are wholly different from the Negroes who inhabit the opposite shores of the Atlantic are exposed to a nearly similar climate and follow nearly the same habits of life

Nor can the differences between the races of man be accounted for by the inherited effects of the increased or decreased use of parts except to a quite insignificant degree Men who habitually live in canoes, may have their legs

g us cas Dr Rolle (*Der M ns h en 1b t m*
m g &c. 1865 s. 99) st t n the th r ty f
Khan k f that th great numb r f C rm f m
ilies settled in Geo g *l acq red n th cours*

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d dual diff re ce t wh ch m mı tl habl m y t h bee preserved and gm ted d ıng l g seri f g e a- t ns th gh nat al selecti n. B t h re we

See Prof Sch uffh us n, tr slat. in *Anthropological Review* Oct. 1868 p 429

M C th tates (N *America Indians* 3rd

coarse and h b as th t f h rse ma hılst th h f th colours fi nd ft.

O th od ur of th k *Godr n, D l'E pec* t m. p 217 O th po es f the kin, D Wil k ns, *Die A fgaben der Landwırth Zoot ch k* 1869 7

are t ce m t by the l jecti n tl at ben fcial anat ns l n an be thu prese ed and as far as we re bled to ȷ d ltl h always l rr thi head none f tl e l ffer

n t b f m cl ımpo tance f ı mpo ɑ tl y w ld l ng ag l been tl r f ed d preserved o l minated In th s re pect u an resembles tl se f rı s, alled by n t ralısts prot an poly rpl c, wl cl h re ai ed tre n ly ari l l o g as t see s, t s cl varı t ns be f an ind ff rent n t re and to the h g tl us sc ped tl e acti n f n t al selecti

W l e th s far bee baffled ın all our ttempts t acco t f tl d ffe nce bet en th race f man b t there remain o e mpor tant ag ncy nam ly Se u l Select n, wl ch ppears t l acted po rf lly n man, as o n any tl anım ls. I d n t ı t nd to rt th t se u l select n w ll acco t f r ll

ltl ro d r arrow r and w tl n se a littl l g o h rt su h l gl t d ff re ce m gl t becom fi ed and u uf rm, f tl u kn wn g cies wl cl ı l ced tl m w re to act m re co t t m n aided by l g co t ı ed ı terecro ng S l ari t come nd tl p o sı al lass, ll ded to n r

fact ıf man h d n t bee modified by th ag cy wh h ppe rs to l acted pow r fully n ınn ın abl an ma.s It n furth be h wn th t tl d ff rence b tw n the races f man as in col haırı as, f m f f tur s, & f kı l wl h ght l e bee pected t com u d th ff nce f se l sel t B t rd to t t this bject p p ly I h f d t necessary t pas th wh l animal kingd m n w I h th f red ted t t th Second Part f thı w k At th l I sh ll t rn to man, and afte tt mpt g to l h w f h l as been modified thro gh al select w ll

fore as these *slight* indications go there seems no foundation for the hypothesis that black *ness has resulted from the darker and darker* individuals having survived better during long exposure to fever *generating miasma*

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Although with our present knowledge we cannot account for the differences of colour in the races of man through any advantage thus gained or from the direct action of climate yet we must not quite ignore the latter agency for there is good reason to believe that some inherited effect is thus produced [65]

We have seen in the second chapter that the conditions of life affect the development of the *bodily frame* in a direct manner and that the

[illegible]

change of *appearance* *Their bodies and limbs* become elongated and I hear from Col Bernys

[illegible]

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[illegible]

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p r to be good gr nds f this m k. On the [illegible] Mr Heddl f S Leone ho has [illegible]

[66] [illegible] Med [illegible] p. 532 Quatrefages (U[illegible] [illegible] 1861 p 128) has collected m ch d nce n this h d

I d st co ect g co ol t nd
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presence of the pe
inclined t think that t has sted in ne hemisphere t least, majority of the br ns of this animal whi h ha p t this tim bee figured or described. The perfi ial pos t of the second bridging co l t is d tly less freque t nd has as t, I belie nly bee see in the brai (A) recorded in this comm nicat n. The asymm trical arra em t in the co ol ti ns of the tw hemispheres, hich prev us bserv rs ha ref rred t in their descript ons, is also w ll llustrated these specim ns (pp. 8, 9)

E were the presence of the t mporo-occipital, or xternal perpendicular ulcus, mark of distinctio bet een the higher pes nd m n, the alue of such distincti charact uld be rendered very d btful by the tructure f the brai the platy hine pes. In fact, whil the t mporo-occipit l ne of th most consta t of ulci in the catarhine Old World, pes, t is er ery tro gly d loped in the N w W ld pes t is bse t th malle platy hine rudime tary in E thecia d more less ol literated b bridging co l ti ns in At les. A haracter which is thus ariabl th th limits of single group can ha no great tax nomic value

It is further established, that th d gree of asym metry of the co l t of th t ides the huma brai is subject t much nd idual ari tio and that, in those indi iduals of th bushman race who ha e bee exami ed the gyri nd ulci of the t h mispheres are consid rably less complicated and more ymm trical than the Europe brain, hile som ndi iduals of th ch mpanzee, th ir complexity and asymmetry becom notable This is particularly th case th brain of ung male chimpanzee figured by M Broca. (*L ord de Primates*, p 16 fig 11)

Again, as respects th q est of bsol t size t is est blished that th differe ce bet ee th largest nd th smallest heal hy huma bra is great tha th difference bet ee th mallest healthy *human brain nd th largest chimpanzee ra g brain.*

Moreo er there is circum ta ce in hich th orang nd chimpanzee brains resemble m s, but h h they differ from th lo er pes, d that th presence of t corpora candica tia—th Cynom rpha having b t ne

I iew of these fact I d not hesitat in this y ar I t repeat nd insist po the propositio hich I unciated in 1863

Flo er 'O the Anat my of P thecs M nachus, Proc ed g of th Zoological Society 1862. M Place Nat p. 102.

panzee nd of ma lm st ns g compared th that bet ee th himpanzee b in nd that of lemur

I the p pe t hich I ha e ref rred, Professo Bischoff does ot d y th second part of this t tem t, b t he first makes th rrele t remark that t is t nd rf l if th b ns of ora g nd lemur are ery differe t nd secondly goes t assert that, *If accu ly compare th b ain of ma th that of* ora g th bra of this th that of himpanzee of this th that of gorilla, nd so of Hylobat s, Sem iop thecus, C nocephalus, Cercopithecus, M cacus, C bus, C llithrix, Lemur t ps, Hapale shall not meet th gre t as gre t bre k the d gree of d l pm t of th co ol t s, as find bet ee th brai of man nd that of an rang h mpanzee

T hich I reply firstly that heth this assertio be true or f lse t has no thi g hat t d th the propositio nciated in M *I lace N t* h h ref rs t t the d l pme t of the co l tions alone b t t the tructure of tl hole brain. If Prof sso Bischoff had tak th *trouble* t refer t p. 96 of the ork h criticises, fact, he would ha f d the follo g passage And t remarkable circumst nce that th ugh, so far as ur prese t kno ledge t nds, there is ne true tructural break th series of forms of simia brains, this hiatus does not h bet ee ma nd the manlik pes, b t bet ee the lo and the lo est simians, or in other ords, betwee th Old nd New World pes d m k y nd th lemurs. Every lemur hich has t bee ex m ed, f ct, has ts cerebellum partially isible from abo nd ts posteri lobe th th co tai ed post ri cor nd hippocampus m or m re or less rudime tary E ery marmoset, America m nk y Old World m nke baboo manlike pe on th co trary has ts cerebellum tirely hidd n, post riorly by the cerebral lobes, nd possesses large posteri corn th ll-d loped hippocampus mi

This tat m t was trictly ccurat ccou t of what was kn h t as mad d t does not ppe t m t be *more tha* ppare *tly* eak ned by th bseque t disco ery of th relat ly sm ll d velopment of th posteri lobes the siama g and in the ho h g m nkey N t thst nd g th ceptional bre ty of th post ri lobes these t pecies, no ne w ll pret nd that their brains, in th l htest degree pproach those of th lemurs. And if inst d of p tting Hapale t of its natural place as Professo Bischoff most nacco tably does, writ th series of imals h has hose t m t f ll w H mo, I thecus, Troglodytes, Hylobates, Semnopithecus, Cynocephalus, C reopithecus, M cacus, Cebus, C llithrix, H pale Lemur tenops, I ture to reaffirm that the gre t break in

give a brief summary of the chapters in this First Part

NOTE ON THE RESEMBLANCES AND DIFFERENCES IN THE STRUCTURE AND THE DEVELOPMENT OF THE BRAIN IN MAN AND APES BY PROFESSOR HUXLEY F R S

The controversy respecting the nature and the extent of the difference in the structure of the b in m man and th ap s wl ch ros me fifteen y ars ag ha not yet com t

gut r p rti ty th t the b a n f all th apes ev n tl e l gh t d ff rs fr m that f m 11 the al nce of such conspicu us str t f the cer bral nu f th late l r contained in man

the truth that the structur in question are as ll de l ped in apes as n hum brains or ver bett r and that t is ch racteristic of all the primate (if ex lude the l mur) to ha the e parts well d velop d tands at p es t o a cure a b s a any pr pos tio n omparati anatomy M reo it s dmitted by ev ry f tl long ser of natom ts h of l

p ed fte the rv e pat t n h s s t tl F y p c pal gyrus t l sulcu of a ch mpa e l

t p n o So y ars in l ofe B ch ff publ l ed tl is tl t t pe

s espe t l m gl d to m ke a tt t n f om l m

That the pes nd e pec ally tl rang ch m p n ce nd go ll com ve y cl e t n th r orga isat o mu h tl nt ny th n l well k f ct d p ted by nobody Look g at the tter fr m tl po nt f e f ga s t alo e pr bably ul l h e d puted th s f I nnæus that m n l uld be pl ced merely a pecul pe t tl h a f th n m l all th t d n

r t d ff ce wl h r lly t So t is w th tl b s Tl b a n f m tl tl ch mp zee tl g ll p t f ll tl mport t d ff en wl l th y present com e y close t o e an th (loc c t p 101)

There remains, then no dispute as to the resem bl c in fundam ntal char ters, bet een the pe brain and man s n r y as to the wonderfully close s mil r ty betwee the cl mpanzee oran nd m n m the deta l of the arrang m nt f the gyri n l sulci f the cerebr l hem pheres. Nor turn g t th d ffere ce

that the man s cer bral l m pl res a e absolutely n l rel g r than tl fætal trus n of

symm tr cally l po ed a d pr se t gr ter number f seco d y pl cat ons. A d it is dmitted th t s a rule the temporo-occip t l r xt rnal perp dic l r fissur h is usu lly s tro gly m ked a f ature of tl pe br but fa tly m rked But t is also cl ar that ne f the d ff r cons t tutes a harp de m c t b t een the man s a d the ape bra n In r pe t to th ext r al perpend cul r fissure of tiol t the hum bra n f r inst nce Professor Turner re arks

t th r gl t l misphere f f n l r n pas e tl t o ch o t nl o tl pee m l o the r ght h m pl r proceeded f r f t tl s f n ch ut th xt ded do rd s f r as the l gin f tl e ut surf ce f the h m ph re Th impe fect d f t f tl fissu the m j rity f lum l s, a compa ed w th ts r k lle l l t ss tl b f most Quadru o g t th pr ce the f rm f cert upe fi l ll ked condary co l t h l l e p. f the lg th l (loc c t p 12)

l h ll t t f tl xt nal perpen l cul fi u (Gr t l t tl r f r t a con ta t t r f tl l l n O th h r han l t f ll t f tl ce tl m re al perpe

cut t us ly t l d tl tl bee ted gi f R ll t M M l ll M Br l f ss T tl ro hus f pec p pe tl ul t tl l tt writes

Tl tl e pec f tl b a f l pa ee just l c bed pro tl t th ge al sat wl l C t l t l tt pted t d w f tl

1 Die Grossh n und ng n des M n h Abh ndlu gen der K B yerisch n Akadem B 1868.

(ro l t n f tl H m Cer br m T pog ap hy C nad d ed 1866 p 12.

Notes respec l th bra n f a ch mp ee Proc d g f th Royal Society f Ed gh 1865-6

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th descrip ns, is
pec m is (pp 8 9)
E w re th prese ce f th t mpo o-occip tal,
t rnal perpe d cul ulcus m k f l t c-
t bet ee th high pe nd m tl l f
h d t tt haract uld be nd ed ry
d btful by th tru ture f the l ra th pl ty
h pes I f t, whil th t mpo o-occ p t l

A haract h h is th bl th tl
l m ts f gl gro p ha gre t t nom
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chimp nzee figured by M B oca. (*L d d Pri at* p 16 fig 11)

Agai respects th q est f b l t t
is est blished th t th d ff re bet ee th largest
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M eo there ircumstance h h th
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y 1874 t repeat d t po th p post
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Fl O th A t my f P th ci M nachus
P oc ed g f th Zool g al Society 1862.
M Pl A t p 102.

panzee d f lmost ns g a l
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tural break th en of f rms f bra ns,
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t pecies ll p t d that tl b is,
th l ght t d gree pproa h those f th l murs.
And f nst d f p tt g H p l t of ts t l
place l rof ss B h ff most ia co tably
doe t th f imals h ha hose t
m t f ll w H m l th cus, Troglodyt s,
Hyl bat s, Sem p thecus, Cynocephal s, C reopi-
thecu M cacus, C bus, C ll thrix, H pal Lem
St ps, I ture to reaffirm that th gre t bre k in

this sene l es between Hapale and Lemur and th t this break is cons d rabl er n

— t in separatı n of the lemurs from the other pr mates on the very groun l of the differ ence in tl cı c rebral ch racte s a d that I rof ssor Flo er had made the f ll ı ıng ob erı t ons in the course f h s d scription of the brain of the Javan loris [3]

And it ı espec lly r markable that, in the de vel pn ent of the poster or lobe th re is no p prox n ation to the lemurı ie short hemı phered brain ı ı th e m nk ys ı l ch are co n ı ly sup po ed to app oach thı family in other re p ects viz the lo ı er m n b rs of the platyrhı e group

So far as the structure f the adult brain s con cerned then the ry considerable additı ns to ur kno ledge wh ch have b en made by th e earches of so many ını st gato s dı ring th pa t te ı years, fully ju tify the st tem nt which I ı de in 1863 But it has been said that adm ıı l e simil r ty es th y are nt b cause ı ı in the mode f th r developme it No one would b more r ady th n I to admit the fo c f th s rgum nt if such fundame tal differenc f devel p nent re lly e ıst. B t I d ny th t th y do ex t. O th cor tr ry there is a fund mental g e m t

I

bra ns of ape and that f m ı—con ting n th s th t n tl e pes tl e sulci which first make the appe rance are situated on th n n f tus, es. s r- ıatıoı th one of a g bbon al ı st ready to be b r ın wh ch the p st n r gyri w re ell de veloped ı hile th s of th frontal l bes w re hardly indicated " (loc cit p 39) a d th other of

a human fœtus at the 2nd or 23rd week of utero g station ın ıh ch Grati l t notes that the nsula was uncov re l but that n rthel ss d ncu ıı semei t de lobe antéri ı u ıe sc peu pr f nd ınd q e la épa t n du lobe occip tal, t t -ıld t, l'a ll urs dè cette époq e Le r t de la u f r cé ébrale e t ei co e bsol t l e

Three views of this brain are gi n n plate II figs 1 2 3 of the work c ted he ıng the upper l t r l ar d u f ri r views l the h m ph res, but n t th inı er ı e ı It is ı orthy of n te th t th figure ly no m ans be r ut Grat l t s d scr pt inas muc l as th fis ure (ant ro-t mp ral) n the pos teri r half f th f ce of the l m ph re ı m re mark d than ny of th se ı gu ly indi ted n the anter or l alf If tl e figure is correct it in n way ju tifi s Gratiolet s conclu n Il y donc e d e ces cer eaux [thos of a C ll thrıx nd f a gibbon] et cel ı du fat s h ma n u e d ffér nce fo d mental Ches c l ı-ci l gtemps ava t que l s pl s t mpor z appar e t l s pl s f lat ıstc lop ı t d the ., Bisch o s n and mo p t cularly by Eck r wh w k is n t or ly th lat t b t ly f r the most cor plete men r n the ubject

Th final results of th r nqu ri s m y be summed up as f ll s —

1 In tl hum n fœtus, th syl n fiss re is fo ned in the c urs of the th rd m nth f ut ro ge tat o ı In thi l m th f urth n onth th cereb l h n pl re are smootl nd rou ded f th

o g ng f tl e s xth m ntl f fœt lif but E k r is ca ful to p nt out tl at n t ı ly th t n e but th rd f th r ppe ra ıce ı s bject t co d r abl ı d du l ıari t n I ı ı cas h ever re tl er the frontal or the t n p ral sulci the earl e t.

[3] Trans ctions of the Zool gical Soci ty vol. v 1862.

déve- ppe t ital at t nt ı pem ns ge é al d lobe f ontal n gé ulem nt pa ppo t d

a peine ma q é The figure ho r (pl fig 3) h ws the fis ure of R land d f th front l sulci plainly n ugh Ne rth l ss, M Al x in his N tice ur l s trav ux nthropol g q s de

Grat l t (Mém de la Société d'Ant polog de l ari 1868 page 32) rites thus C at act eu d e l m l rre d fat d C bbo n et ém nemment péneu ett llem nt pproché l'or g q d nat l t t è complétements l nt gé parm l ntl paul M H xl y pa zempl h t le pa po u. El bi t l er d n fat d C bbo q G t ol t n l

t dia q hes

E rch d ı isphäre des ı y t th opol gie 1868

" Zu l t kl g ges l lt d E l d W l g n d Grossl rn Hem pl a n m Fœtus des M nsch Arr f Anth pologie iii. 1868.

The first hich ppears, in fact, lies the inner face of the hemisphere (hence doubtless Gratiolet, who does not seem t have xamined that face his fœtus, overlooked it), and is either the internal perpendicular (occipito-parietal), or the calcarine ulcus, these t being close t gether and ve tually running int one another ts rule the occipito-parietal the earlier of the two.

frontal, parietal, temporal and occipital lobes. There is, however no clear evide ce that one of these constantly ppears before the other and t is remark able that, in the brain t the period described and figured by Ecker (loc cit., pp. 212 13 tab. II, figs. 1 2, 3, 4), the antero-temporal sulcus (*scissure parallele*) so characteristic of the ape brain, is as ll, if not better developed than the fissure of Rolando, and is much more marked than the proper frontal ulci.

Taking the facts as they no stand, it appears t me that the order of the ppearance of the sulci and gyri in the fœtal human brain is in perfect harmon with the general doctrine of evolution, and with the view that man has bee evolved from some ape-like form though there can be no doubt that that form as, in many respects, differe t from any member of the primate now livin

Von Baer taught us, half century ago, that, in the course of their de elopme t, anied nimals put on at first, the characters of the greater groups t hich the belong, and, by egrees, assume those hich restrict them ithin the limits of their family genus, and species and he proved, t the sam tim that no develop me tal stage of higher animal is prec sely simuar t the adult conditio of any lo er animal. It is qui correct to say that frog passes through the condition of fish, nasmuch as t ne period of its lif the tadpole has all the characters of fish, and if t w nt no further w uld ha t be grouped among fishes. B t t is equally true that tadpole is very different from an know fish.

In like manner the brain of human fœtus, t the fifth month, may correctl be said t be not nly the brain of an ape, but that of an arct pithecine or marmoset lik pe for ts hemispheres, with their great posterior lobster and with no sulci but the sylvian and the calcarine prese t the characteristics found n in the group of the arctopithecine primates. But it is equall true as Gratiolet remarks, that, in its widely open syl ian fissure it differs from the brain of any actual marmoset. N doubt t ould be much more similar t the brain of an advanced fœtus of marmoset. But w know nothing wha ev marm servati Panseh

deep calcarine fissure nly ry shallow terotemporal fissure (*scissure parallele* f Gratiolet).

N w this fact, tak t gether w th the circumstance that the tero-temporal ulcus is prese t in such Platyrhini as the Saimiri, hich prese t mere traces of sulci on the anterior half of the terior of the cerebral hemispheres, or none t all, undoubtedly so far as t goes, a ords fair evidence in favour of Gratiolet hypothesis, that the posterior sulci ppear before the anterior in the brains of the Platyrhini. B t, t by no me ns follows, that the rule hich may hold good for the Platyrhini t nds t the C tarhini. W ha no informatio whate er respecting the dev lo m t of the brain the Cynomorpha and, as re ards the A thropomorpha, nothing but the accou t of the brain of the gibbon near b rth, already referred to. At the prese t mome t there is not shadow of idence t sh w that the sulci of himpanzee s, or orang s, brain do not ppear in the same order as ma s.

Gratiolet ope his preface th the phorism *Il est da gereux dans le science de concl re trop vite* I fear he must ha forgott this sound maxim by the tim he had reached the discussion of the differences bet ee me and pes, the body of his ork. N do t, the excelle t thor of ne of the most remarkable contributions t the just understand g of the mammalian brain hich has er bee mad would ha bee the first t admit the insufficiency of his data had he lived to profit by the advance of inquiry The misfortune is that his conclus ons have bee employed by persons incompet nt t ppreciat their f nda ion, as arguments in f our of obscurantism.[*]

But it is important to remark that, hether Gratiolet was right or wrong his hypothesis respecting the relative order of ppearance of the temporal and fro tal sulci, the fact remains that before ther t mporal or fro tal sulci, ppear the fœtal brain of man prese ts characters hich are found nly in the lo est group of the primates (leaving out the lemurs) and that this is exactly what hould xpect t be the case if man has resulted from the gradual modificatio of the sam form as that from hich the other primates have sprung.

[*] For example M. l'Abbé Lecomte in his terrible pamphlet, *Le Darwinisme et l'origine de l'homme*, 1873.

Part Two

Sexual Selection

CHAPTER VIII

PRINCIPLES OF SEXUAL SELECTION

WITH animals which have their sexes separated the males necessarily differ from the females in their organs of reproduction and these are the primary sexual characters But the sexes often differ in what Hunter has called *secondary sexual* characters which are not directly connected with the act of reproduction for instance the male possesses certain organs of sense or locomotion of which the female is quite destitute or *has them more* highly-developed in order that he may readily find or reach her or again the male has special organs of prehension for holding her securely These latter organs of infinitely diversified kinds graduate into those which are commonly ranked as primary and in some cases can hardly be distinguished from them we see instances of this in the complex appendages at the apex of the abdomen in male insects Unless indeed we confine the term primary to the reproductive glands it is scarcely possible to decide which ought to be called primary and which secondary

The female often differs from the male in having organs for the nourishment or protection of her young such as the mammary glands of mammals and the abdominal sacks of the marsupials In some few cases also the male possesses similar or ans which are wanting in the female such as the receptacles for the ova in certain male fishes and those temporarily developed *in certain male frogs The females of* most bees are provided with a pecial apparatus for collecting and carrying pollen and their ovipositor is modified into a sting for the defense of the larvæ and the community Many similar cases could be given but they do not here concern us There are however other sexual differences quite unconnected with the primary reproductive organs and it is with these that we are more *especially concerned*—such as the greater size strength and pugnacity of the male his weapons of offence or means of defence against rivals his gaudy colouring and various ornaments his power of song and other such characters

Besides the primary and secondary sexual differences such as the foregoin the males and females of some animals differ in structures related to different habits of life and not at all or only indirectly to the reproductive *functions Thus the females or certain flies* (Culicidæ and Tabanidæ) are blood suckers, whilst the males living on flowers have mouths destitute of mandibles[1] The males of certain moths and of some crustaceans (e g Tanais) have imperfect closed mouths and cannot feed The complemental males of certain cirripedes live like epiphytic plants either on the female or the hermaphrodite form and are destitute of a mouth and of prehensile limbs In these cases it is the male which has been modified and has lost certain important organs which the females possess In other cases it is the female which has lost such parts for instance the female glow worm is d stitute of wings as also are many female moths some of which never leave their cocoons Many female parasitic crustaceans have lost their natatory legs In some weevil beetles (Curculionidæ) there is a great difference between the male in relation to different habits of life are generally confined to the lower animals but with some few birds the beak of the male differs from that of the female In the Huia of New

[1] Westwood *Mod n Cl* *ficat o* *f Insect* 1840 p 41 F r th t t t b t T au m t ed b l w I am d bted t F t Müll r Kirby d Spe ce *Int oduct* *to E t mology* 1826 p 309

Zealand th d ff re ce ı wo d rf lly g e t, and h ar f om D B ller[1] tl at tl e male se hı t ng beak ı ch sell g th lar ae f ıns ts t f d ayed ood wh l t th f male p be th soft r p ts th h r far l g r m h rved d pl ant b ak d tl s th y m t lly d ach tl In mo t cas s, d ff ces f t tu b tw n the s e m re l ss d re tly connected with tl p p g tı n f the pec s th f m le wh cl has to n urish a m ltıt de f a, eq m r food than tl mal a d cons q tly eq r speci l m s f r proc g t. A m l anımal, wh ch l es f y h t t m m ght l se t gans f p oc g food tl gh d use w th t d t m t but h w ld cta h s locom tı ga n perf ct tat so tl t l might ach th fem l Th fem le tl

us l ss

W ar h he co cerned ly with

reprod tı Wh as th cases ab m t ed th t d ff n stru t n rel t t d ff th b ts f life th y l e n d bt b mod fied thr gl tur l select and by h tance lım ted t d the sam So gaı th p mary l g ns, and th e f n h g prot t g the y g com d r th sam fl ce f r th se dı d al wh h g ted n hed th ff prı g h t ld l cet ris parıb th g t t mb to nl t th pe rıty hıl t tl se wh h g r t do l ed th r ff p g badly ld l b t f w t l nt tl k po ls th m l has t fi d

f m l h som t m bsol tely q es pre l ns l gans t h ld h th D W llace nf rm m th t th mal f certaın m th an t nıt th th f mal ıf th t r feet ar b k Th mal f many oc anı crustacean wh ad lt h th ır l gs and t nure modified ın an t aord ry man f th p h ns f th f mal h n w m y pect th t t ıs because th se anımal ar

washed about by the w ves of the open sea, that prop n r s lec sc l l

pe as

Wl n tl t sex f llow xactly tl e sar h b ts f l f and tl m le l as tl e sensory r locom t ve gans m re h gl ly dev l ped tl an those f tl e f m l ıt m y b that tl e perf c t f th se ı ı d pensabl to tl e mal f r fi d g tl f male but n tl e vast m jority f

f r th ordı ary l b ts of l f S ce ın l case tl e m l l a acqu ed tl e prese t str t n t f m b g bett fitted t r

to tl l ff p g al se l select n must h e ha co t act It was tl ımportance f th dıstınctı which led me t

t th scape f tl f mal b f e the arrıval f th r m l r when assaulted by tl th g w ll h been perf cted tl ro gh l lectı n tl t ıs by th ad antag acq ed by certaın ınd ıdu l o er tl r rı als B t n m t ase of th kınd ıt s ım possıbl to dıst guı h b t ee th ffects of natural a d al el ct Wh l chapters

[1] B ds f New Z aland 1872, p. 66

M P rr ad ce th as (Revu Sci nt fq F b. 1 1873 p 865) as f tal t th bel f

could be filled with details on the differences between the sexes in their sensory, locomotive and prehensile organs. As, however, these structures are not more interesting than others adapted for the ordinary purposes of life, I shall pass them over almost entirely, giving only a few instances under each class.

There are many other structures and instincts which must have been developed through sexual selection—such as the weapons of offence and the means of defence—of the males for fighting with and driving away their rivals—their courage and pugnacity—their various ornaments—their contrivances for producing vocal or instrumental music—and their glands for emitting odours, most of these latter structures serving only to allure or excite the female. It is clear that these characters are the result of sexual and not of ordinary selection, since unarmed, unornamented, or unattractive males would succeed equally well in the battle for life and in leaving a numerous progeny, but for the presence of better endowed males. We may infer that this would be the case, because the females, which are unarmed and unornamented, are able to survive and procreate their kind. Secondary sexual characters of the kind just referred to, will be fully discussed in the following chapters, as being in many respects interesting, but especially as depending on the will, choice, and rivalry of the individuals of either sex. When we behold two males fighting for the possession of the female, or several male birds displaying their gorgeous plumage, and performing strange antics before an assembled body of females, we cannot doubt that, though led by instinct, they know what they are about, and consciously exert their mental and bodily powers.

Just as man can improve the breeds of his game-cocks by the selection of those birds which are victorious in the cock-pit, so it appears that the strongest and most vigorous males, or those provided with the best weapons, have prevailed under nature, and have led to the improvement of the natural breed or species. A slight degree of variability leading to some advantage, however slight, in reiterated deadly contests would suffice for the work of sexual selection; and it is certain that

an erect and peculiar carriage—so it appears that female birds in a state of nature, have by a long selection of the more attractive males, added to their beauty or other attractive qualities. No doubt this implies powers of discrimination and taste on the part of the female which will at first appear extremely improbable; but by the facts to be adduced hereafter, I hope to be able to shew that the females actually have these powers. When, however, it is said that the lower animals have a sense of beauty, it must not be supposed that such sense is comparable with that of a cultivated man, with his multiform and complex associated ideas. A more just comparison would be between the taste for the beautiful in animals, and that in the lowest savages, who admire and deck themselves with any brilliant, glittering, or curious object.

From our ignorance on several points, the precise manner in which sexual selection acts is somewhat uncertain. Nevertheless if those naturalists who already believe in the mutability of species, will read the following chapters, they will, I think, agree with me that sexual selection has played an important part in the history of the organic world. It is certain that amongst almost all animals there is a struggle between the males for the possession of the female. This fact is so notorious that it would be superfluous to give instances. Hence the females have the opportunity of selecting one out of several males, on the supposition that their mental capacity suffices for the exertion of a choice. In many cases special circumstances tend to make the struggle between the males particularly severe. Thus the males of our migratory birds generally arrive at their places of breeding before the females, so that many males are ready to contend for each female. I am informed by Mr. Jenner Weir that the bird-catchers assert that this is invariably the case with the nightingale and blackcap, and with respect to the latter he can himself confirm the statement.

Mr. Swaysland of Brighton has been in the habit, during the last forty years, of catching our migratory birds on their first arrival, and he has never known the females of any species to arrive before their males. During one spring he shot thirty-nine males of Ray's wagtail (*Budytes raii*) before he saw a single female. Mr. Gould has ascertained by the dissection of those snipes which arrive the first in this country, that the males come before the females. And the like holds good with most of

mol ...

acquired by the parent species can give to the Sebright bantam a new and elegant plumage.

th m grato y b rd f the Unit d Stat Tl e m jo tv f th male salmon o n s, n coming up from the sea, are ready to b eed bef re tl e femal s. So t ppe to b w th frogs and t ad Thro gh t tl e gre t class f sects th m l s alm t alw are th first to m g from tl e p p l tat so tl at th y g ally l u d f tum l f e any f m les can be see Tl e a se f tl d ff r ce b t tl m l and f mal th r period of

ady t b eed w th m t r w l a th large t n mb r f ff pri g nd tl se ld t d t inherit m lar t ts ets l co t t t It mu t be b e nu d

y ung— perιou th seasons f tl v ar O tl h l th re ca b d bt tl t th lmost all mals, n lu l tl a par te tl a co t tlv ec t truggl between th m l f th possess f th f mal

O diff lty reg rd t se al select n l d tand g l t th t th mal hich co q th m l s, th se wh ch pro tl m t tt acti t th f m l l g eat umb f ff pri to mh t tl r pe rity tl tl b t and l ss ttrac t als. L l ss tl lt does f llow tl e haract l h g t ce t mal an ad antag th s, ld t b perfected and gm ted tl h se l lect n. Wh n th ex xi t actl q al mbers, th rst-e d ed l w ll (cej t wh polyg m p all) ltim t l fi d f m l s, and l s man ff p g as ll fitted f th ir g al h b t f l f as tl b t d ed m l F m facts and nsid rat I f m ly nf ed tl t with m t animals, in wl h sec dary se l haracte ar w ll d l ped tl m l co d bly c ed d

tl e f m l s in number b t tl is t ot by any ca s l ay true If th males w re to tl e f m l s as two to o e or as tl ee t two or e c a sot e l at l we r to, tl e wl le

eq al ty numl co nm ly xists In t t case sex al select n i pears to have been effect the f ll g m an er

m re b als, a d th tl r f the l ss g ro s a l l calth y Tl e fore e tl e can be l ttl d l t wo ld be r ad to breed n tl j ring bef re th tl rs and thu s tl n of M J n n W wl o has ar f lly tte ded to tl e l b ts f b rd d ri g many y rs. There can lso be d bt tl t tl most g us, be t n ri hed and e l t l ed s w ll an ge eceed reari tl largest nu ber f f ff pring Th males, as w l een are gene ally ready t l eed bef re tl e f m l tl tro g t, and w th some pec s tl f t armed f the males, dri a y tl e w ak an l tl e f rm wo ld tl t w tl tl m re g ro and b tt n ri l ed femal s, because they are tl first to breed S ch g ro pairs w ld ly rear a larg mbe f ff j ri g than tl tarded f mal s, wl h w ll b compelled t unite w th tl e co qu red and l pow f l m l s, i po ng tl se t be n m rically q al and th all tl t wanted t add th co se f ccess g r ti ns t tl e tre gth d coura g f tl m l to mpro th weapo

B t in ry many case th males wl cl co q th r ri ls, do n t obtain possess f the f mal d pe d ntly f the ch ce f

hich th f mal g ns ar bef re-ha d.

'Hre cell t d ce th ch t f th ff p g from exper ced th l gist. M J A All pe k g (M mmal nd W nter B ds f E Florid p 229) f th l t broods, It th ac-

rul tl b d f th l b oods seem ll re-

the latter The courtship of animals is by no means so simple and short an affair as might be thought The females are most excited by or prefer pairing with the more ornamented males or those which are the l r

r

t more vigorous and lively males and this has in some cases been confirmed by actual observation [9] Thus the more vigorous females which are the first to breed will have the choice of many males and though they may not always select the strongest or best armed they will select those which are vigorous and well armed and in other re pects the most attractive Both sexes therefore of such early pairs would as above explained have an advantage over others in rearing offspring and this apparently has sufficed during a long course of generations to add not only to the strength and fighting powers of the males but likewise to their various ornaments or other attractions

In the converse and much rarer case of the males selecting particular females it is plain that those which were the most vigorous and had conquered others would have the freest choice and it is almost certain that they would select vigorous as well as attractive females Such pairs would have an advantage in rearing offspring more especially if the r l l d the ring am or the young The same principles would apply if each sex preferred and selected certain individuals of the opposite sex supposing that they selected not only the more attractive but likewise the more vigorous individuals

Numerical Proportion of the Two Sexes —I have remarked that sexual selection would be a simple affair if the males were considerably more numerous than the females Hence I was led to investigate as far as I could the p o portions between the two sexes of as many animals as pos ible but the materials are scanty I will h re give only a brief abstract of the results retaining the detail for a supplementary discus ion so as not to interfere with the course of my argum nt Domesticated animal alone afford the means of ascertaining the proportional numbers at birth but no records have been pecially kept for this purpose By indirect means, however I have collected a considerable l l x

o births of race horses have been recorded during twenty one years and the male births were to the female births as 99 to 100 In greyhounds the inequality is greater than with any other animal for out of 68 8 births during twelve years the male births were to the female as 110 1 to 100 It is however in some degree doubtful whether it is safe to infer that the proportion would be the same under natural conditions as under domestication for sl ht and unknown differences in the conditions affect the proportion of the sexes Thus with mankind the male births in England are as 104 in Rus ia as 108 9 and with the Jews of Livonia as 1 0 to 100 female births But I shall recur to this curious point of the excess of male births in the supplement to this chapter At the Cape of Good Hope however male children of European extraction have been born during several years in the proportion of between 90 and 99 to 100 female children

For our present purpose we are concerned with the proportions of the sexes, not only at birth but al o at maturity and this adds another element of doubt for it is a well ascertained fact that with man the number f mal s dying before or during birth and during the fir t two years of infancy is con iderably larger than that of females So it alm t certainly is with male lamb s and probably with some other animals The males of some species kill one another by fighting or they drive one another about until they become greatly emaciated They mu t also be oft n expo ed to various dangers whilst wandering about in eager search for the females In many kinds of fish the males ar much small r than the fe mal and they are b he ed often to be devoured by the latt r or by other fi he Tl femal s of som birds appear to h her th n the males they are al o h bl to be d troyed on thei r e t l l t in harge of their young With insect tl female larva are often larg than tl o f tl mal s, and would c n quently b n or lik ly to be devoured In so n cases the natu females are le s active a l l s a l in their mo ements than the mal s, and could not escape so well from dang r Hence with animal in a stat of

nature, w must rel on m re est m ti n, n order to j d~e of th proporti ns of th sexes t maturity and thu is b t littl trustw rthy except wh th inequality is strongly marked. N rth less, as far as a j dgm t can be formed, w may concl d from the facts gi n in the s pplem t, that the males of some few mammals, of man birds, of some fish and in sects, are consid rably m re numerous than the f males.

Th proporti n between the se es fluctuates s~atl during successi e y ars thus with race-horses, f ry 100 mares born th tal- lons aried from 10 1 i o ear to 9~6 in anothe ar and w th gre bound from 116.3 t 95.3 B t had larg numbers been tabu lated throu hout an are m re xt nsi than England, these fluctuations would probabl ha d sappeared and h as th are w uld hardl suffice to lead to ffecti sexual selec- tio in a tate of n ture N rth less, the case of som f w wild animals, as sh wn in the pp~em t, the proporti ns seem to fluctuat th during diff rent seasons in d~ rent localities ffici t d gree to lead t uch select n. F t should be observed that any ad antage gained durin certain ears or in certai localit es b those males which w re able t conq th ri ~a.s, o w re th most ttracti to th f males, would probabl be transmitted t th off pring, and would not bseq ntl be liminated Durin the succeedin seasons, wh n, from th equal t of th sexes, ry male was abl t procure f male th tron~ m re ttracti males pre iousl prod ced would still ha t l ast as good nance f lea ing off pring as th w ake or less ttracti e.

Polygamy —Th practice f pol gamy leads to the sam results as would *follow from* an actual inequalit in th numbe of th se es for f each male secures two more f *males*, man males cannot pai and th latt as- suredl ll be the w ak less ttracti indi iduals. Man mammals and som f w b rds are pol gamous, b t with animals be- lo ging to t lo lasses I ha f und no idence of thi hab t. Th int llectual pow rs of uch animal are perhaps not suffici t to lead th m t collect and guard harem of fe- males. That som relati n xists between pol gam and the dev lopm t of secondary se ual charact rs ppears earl certain and thus pports the w th t numerical pre- pond rance of male would be eminently f ourabl t th acti n of sexual selecti n. N rth less man animals, which are trictl m nogamous, especially birds, display strongl marked secondary se ual charact rs whil t some f w animals, which are pol gamous, d n t h e ch charact rs.

We will first bri fl run through the mam mals, and then turn t birds. The g rilla seems to be pol gamous, and th male diff rs con- sid rably from the femal so t is with som baboons, which li e in herds co tainin twice as many adult females as males. In So th Am rica th *Mycet s caraj* present w ll marked sexual diff rences, n colour beard and ocal rgans and the male gen rall li es w th tw r three wives the male f the *C bus capuci us* diff rs somewhat from the f male and appears to be polygam us.[18] Little s known n thi head w th respect to most th monk s, b t some species are strictly mo- nogam us. Th ruminants are mai ntly pol g amous, and th present sexual d ff rences more freq ntl than almost any other gro p of mammals this hold good, especially in th ir weapons, b t also in th charact rs. Most dee cattle and sheep are polygamous as are most ant l pes, tho h som are mo o- gamous. Andrew Smith, in peaking of th ant lopes of So th Africa, sa that in h rds of about a doze th re was rarely more than ne mat re mal Th Asiatic *Antilope sai a* p- pears to be the most inord nat pol gamist in th world f Pallas tates that th male dri es w y all ri als, and collects a h rd of abo t hundred f males and kids t g th th f male hornless and has softe hai b t does not th rwise diff much from th mal Th wild horse f th Falkland Island and of th west rn states f N Am rica is pol g mous, but, xcept in his gre te size and n the proportions f his bod diff rs b t littl from th mare. Th wild boar prese ts well marked se al charact rs, in his great tusks and some ther points. In Europe and in India h l ads a soutary *lif* cept during th breedin se son b t as is beli ed by ir W Elliot, who

[18] Sir Andrew mith, *Il strations of the Zoology of S. Africa*, 1849 pl. 29 the Kobus. Ow his *Anatomy of V rtebrae* (vol. iii., 1868, p. 633) gi es table shewing incide tally hich species of antelopes are gre~arious.

has had many opportunities in India of observing this animal he consorts at this season with several females Whether this holds good in Europe is doubtful but it is supported by some evidence The adult male Indian elephant, like the boar passes much of his time in solitude but as Dr Campbell states when with others It is rare to find more than one male with a whole herd of females the larger males expelling or killing the smaller and weaker ones The male differs from the female in his immense tusks greater size strength and endurance so great is the difference in these respects that the males when caught are valued at one fifth more than the females [12] The sexes of other pachydermatous animals differ very little or not at all and as far as known they are not polygamists Nor have I heard of any species in the Orders of Cheiroptera Edentata, Insectivora and rodents being polygamous excepting that amongst the rodents the common rat according to some rat catchers lives with several females Nevertheless the two sexes of some sloths (Edentata) differ in the character and colour of certain patches of hair on their shoulders [3] And many kinds of bats (Cheiroptera) present well marked sexual differences chiefly in the males possessing odoriferous glands and pouches and by their being of a lighter colour [14] In the great order of rodents as far as I can learn the sexes rarely differ and when they do so it is but slightly in the tint of the fur

As I hear from Sir Andrew Smith the lion in South Africa sometimes lives with a single female but generally with more and in one case was found with as many as five females so that he is polygamous As far as I can discover he is the only polygamist amongst all the terrestrial Carnivora and he alone pre ents well marked sexual characters If however we turn to the marine Carnivora, as we shall hereafter see the case is widely different for many species of seals offer extraordinary sexual differences and they are eminently polygamous Thus according to Peron the male sea elephant of the southern ocean always possesses several females and the sea lion of Forster is said to be surrounded by from twenty to thirty females In the North the male sea bear of Steller is accompanied by even a greater number of females. It is an interestin fact, as Dr Gill remarks [15] that in the monogamous pecies or those living in small communities there is little difference in size between the male and females in the social pecies, or rather those of which the males have harems, the males are vastly larger than the females.

Amongst birds many species the sexes of which differ greatly from each other are certainly monogamous In Great Britain we see well marked sexual differences, for instance, in the wild-duck which pairs with a single female the common blackbird and the bullfinch which is said to pair for life I am informed by Mr Wallace that the like is true of chatterers or Cotingidæ of South America, and of many other birds. In several groups I have not been able to discover whether the species are polygamous or monogamous. Lesson says that birds of paradise so remarkable for their sexual differences are polygamous, but Mr Wallace doubts whether he had sufficient evidence Mr Salvin tells me he has been led to believe that humming birds are

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black cock differ greatly from the females whilst the sexes of the monogamous red grouse and ptarmigan differ very little In the Cursores, except amon t the bustards few species offer strongly marked sexual differences, and

Dr Gray in An al [illegible] Natural History 1871 p 302.

See Dr Dobson [illegible] paper [illegible] Proceedings of the Zoological Soc ty 18 3 p 241

[15] "The Eared Seals, American Nat alist vol. i J n 1871

The Ib [illegible]

[illegible] black grouse as polyg m us and of [illegible] red grouse as m gam us.

the gre t bustard (*Oti t rd*) s said to be pol, gamous. With the Grallat res, xtrem ly f w pecies diff r sexuall b t the ruff (*Machete p gnax*) aff rds marked except n, and this pecies is bel e ed by M ntagu to be pol gamist. Hence t ppears th t am g t birds th re often xists close relation between pol gamy and th d lopm nt of strongly marked se al diff rences. I asked Mr Bartlett, f th Zoological Gard ns, who has had ry larg xpe ce with b rds, wheth th male trag pan (ne f th Gallinaceæ) was pol gamous, and I was struck by his answ ring, I d not know b t sh ld think so from hi plendid colours.

It desers notice that th instinct of pairing with singl female is easil lost und r domestication. Th w ld-d ck is tri tly monogamo s, th d mestic-d k l ghly polygamous. Tl R W D Fox inf rms me that out of som half tamed wild-d cks, on a large pond in his gl bo hood so man mallards w re shot b th game-keepe that only on was l ft for ry se n or ght f males y t unusuall larg broods w re reared The gume f wl stri tly m nogamous b t Mr F x find th t his birds succeed best wh n he keep cock to tw three h s. Canary birds pair tat of nature b t the breed rs F l nd successf ll p t mal to f ur

d es t au us w p an c

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far as can judge, sexual selecti has led to the d k pm t f secondary sexual characters. It has bee sh wn that th largest numbe of vi ro ffspring will be reared from th pa ring f th tro gest and be t armed males, vict ri us in cont ts o th mal s, with th most g rous and best nourished f mal s, whi h are th first t breed in th spring If h f mal select th m re ttrac m re attract e and t the same t me h al t y and vigoro s females and this will especi lly hold good f the male d f nds tl femal and aids pro iding food fo the y ung Tl ad antag thus gai ed by tl e more gor s pairs n rearing a large number of off pri has pparentl sufficed to render sexual selection ffici nt B t a large n merical p po d rance f males er f males w ll be till more ffici nt whetl r the preponderance s nl occasi nal and local, or perman nt wh th r t occurs t birth, o afterwards fro n wh th r t indirectl f llo s from the practice of pol gamy

The Male generally more mod fied tha the Female —Througl o t the animal kingd m, when th sexe diff in xternal appearance t is, w th rare exceptions, th male which has een ll the

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m mbers of th same group. The cause seems t h in th males of almost all anim als h ing tro ger passion than th females. Hence t is th males that fight tog ther a l sedulousl d pl thei charms bef re th females and th tors transmit tl superi t t th mal off pring. Why botl sex s do n t thu acquire th haracters of th ir f th rs, will be consid red hereaft That the male of all mammals ag l pursu th f m les n tori us to ry one So t is with bird b t many cock b rd d not so much pursu tl e h n, as di pla th pl mage, perform tra e antics, and po f rth th so g in h pres-nce Th m l n th f w fish observed seems m ch m re than th f mal and tl e sam is tru of all gators, and pparentl of batrachians. Thro gh t th nori o l ss f insects, as Kirb remarks, th law is th t th mal shall seek the f male. [1] Two goo l authorit es, Mr Blackw ll and M C Spe ce B t t ll m th t the males f p l rs d crustaceans are m re acti and more rrat in their hab ts than th f males. Wl n th rgans of sense locomoti are present th se f nsect and cru tacean d absent in th th wh as freq tly th case th are m re h hly d loped in th than tl th t is, as far as I ca disco almo t ariably th m l wl h retains l rg s has th m most d l-

Noel Humphreys, *R er Ga dens*, 1857

[1] K rby nd pe ce *Introductio to Entomology* vol. ii., 1826 p. 342.

has had many opportunities in India of ob serving this animal he consorts at this season *with several females Whether this holds good* in Europe is doubtful but it is supported by some evidence The adult male Indian ele phant like the boar passes much of his time in solitude but as Dr Campbell states when with others It is rare to find more than one male with a whole herd of females the larger males expelling or killing the smaller and weaker ones The male differs from the female in his immense tusks greater size strength and endurance so great is the difference in *these respects that the males when caught are* valued at one fifth more than the females [12] The sexes of other pachydermatous animals differ very little or not at all and as far as known they are not polygamists Nor have I heard of any species in the Orders of Cheiroptera Edentata, Insectivora and rodents be ing polygamous excepting that amongst the rodents the common rat according to some rat catchers lives with several females Never theless the two sexes of some sloths (Edentata) *differ in the character and colour of certain* patches of hair on their shoulders [13] And many kinds of bats (Cheiroptera) present well marked sexual differences chiefly in the males possessing odoriferous glands and pouches and by their being of a lighter colour [14] In the great order of rodents as far as I can learn the sexes rarely differ and when they do so it is but slightly in the tint of the fur

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black cock *differ greatly from the females* whilst the sexes of the monogamous red grouse and ptarmigan differ very little In the Cur sores, except amongst the bustards fe species offer strongly marked *sexual differences, and*

[15] 'The Eared Seals, *American Nat al t* v l. J n 1871

The Ibis v l. 1861 p 133 the l rog e w dow b rd. See als th *Idua ar ll bid* l. 1860 p 211 O th polyg y f the caper l d k t l ust rd see L. Ll yd *G me B d f Sw d n*, 1867 pp 19 nd 182 M tagu d Selby pe k f th bl k grouse as polyg m us d of th red grouse as m gam us.

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th m les He had pre ly ma eu th t alt g the m 102 s bjects, tl ari ties f red danc e fo nd to b l lf as many agai as f mal s, contr asti g w d ly with th great r freq y f d fi n y i f m l s bef re d scribed I f ssor Macal t r like w se m ks tl t ari t n tl sel re prol l ly m re comm n in l s than fe m les. C rt m sel s wl l re t n r mall p se t n in nk d re lso mo fre q tly d l ped tl m l tl an tl f m le sex, ltl gl cept t th rul re said t occu D B t W lde[28] l as tab l ted tl ase f 1 2 l d l w tl pe n ary d g ts, f l l 86 w m les, d 39 les tl l lf f m l tl remai g 7 b g

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th ars f m are m re ar abl f rm tl an th se f man[27] Lastl tl t mp t e m ari bl m th man[28]

Tl f tl gre t g al ari b l ty th mal th n tl f m l s nkn wn, cept so f as seco dar se l l act rs ar t rd nl ari bl d ally co fined t tl mal an as w shall p es tl see tl fact to certai t t, t ll gibl Tl ro gh tl t f se al and t al select l m l l bee

t t t lly t d t rv som wh t diff t mann Tl f m l has t xpend m cl gani tt tl f t f h a, h as tl l p d m el f n f rce co t ts w tl l ls, w d ri g bo t se rel f tl f m l rt g his ce po ring t od ni ro sec t s, &c. an l th p l t g lly co t ted th l t period Tl g t g f th mal d ri g th seaso f l se m ft t int fy l col s, d pe d tly f y

marked d ff re ce from tl e fen ale[29] In man kind a l r e scale as the box mal i I r p f matter and force by tl e two sexe j rob t l rly qual th ugh eff cted in ry

t n at least d ri g tl e l recdi g seaso altl gl tl y y be bjected to actl tl sam e l t s, tl ll tend t ary in a d ff re t an r If l ri tl s a e f no serv ce to tl r se tl ey will t be acc mu l t d a i reas l l y sc al or n tu al selec t N rtl el ss, they n y b come perm e t f tl x ti g se act perma ntly and i accordance w th a freq t f rm f inl rit ce tl y m y b tr n itted to tl t sex l i wl cl tl y first ppeared In tl is case tl t s w ll co to p esc t pe m t y t po tai t l ff i es f cl ar act F i t ce Mr All l tl t w tl larg l f b rd nl l ting tl e rtl l s tl ri L ted St t s, tl e pecim s

app ar t h e be n d ff re tly ffected tl lg lu pl us the male ha l ad th col rs gre tly t f ed tl e so tl nl as n tl C d al i g s it th femal wl l l bee th affected witl Q scal m j tl e f m l h e b n re d ed t ly ari bl t t whil t tl e m l rem n n ly f rm[31]

A f w cept l ases occur in v r u class f n m l n wl l tl e f l s n t ad f tl m l l acq red w ll pro-

[30] F m ki l ce D J Stockt H gh, wl os co l re g th I pul S ienc Review 1874 p 97 See G rard bse at th Lep d pt a, as gi th Zool gical Record 1869 p 347

[31] M mmal nd B ds f E Florida pp 234 280 295

oped and this shews that the male is the more active member in the courtship of the sexes [19]

The female on the other hand with the rarest exceptions is less eager than the male As the illustrious Hunter[20] long ago observed she generally requires to be courted she is coy and may often be seen endeavouring for a long time to escape from the male Every observer of the habits of animals will be able to call to mind instances of this kind It is shown by various facts given hereafter and by the results fairly attributable to sexual selection that the female though comparatively passive generally exerts some choice and accepts one male in preference to others Or she may accept as appearances would sometimes lead us to believe not the male which is the most attractive to her but the one which is the least distasteful The exertion of some choice on the part of the female seems a law almost as general as the eagerness of the male

We are naturally led to enquire why the male in so many and such distinct classes has become more eager than the female so that he searches for her and plays the more active part in courtship It would be no advantage and some loss of power if each sex searched for the other but why should the male almost always be the seeker? The ovules of plants after fertilisation have to be nourished for a time hence the pollen is necessarily brought to the female organs—being placed on the stigma by means of insects or the wind or by the spontaneous movements of the stamens and in the Algæ &c by the locomotive power of the antherozooids With lowly organised aquatic animals permanently affixed to the same spot and having their sexes separate the male element is invariably brought to the female and of this we can see the reason for even if the ova were detached before fertilisation and did not require subsequent nourishment or protection there would yet be greater difficulty in transporting them than the male element because being larger than the latter they are produced in far smaller numbers So that many of the lower animals are in this natural that any of their descendants which rose in the scale and became locomotive should retain the same habit and they would approach the female as closely as possible in order not to risk the loss of the fertilising element in a long passage of it through the water With some few of the lower animals, the females alone are fixed and the males of these must be the seekers But it is difficult to understand why the males of species of which the progenitors were primordially free should invariably have acquired the habit of approaching the females instead of being approached by them But in all cases in order that the males should seek efficiently it would be necessary that they should be endowed with strong passions and the acquirement of such passions would naturally follow from the more eager leaving a larger number of offspring than the less eager

The great eagerness of the males has thus indirectly led to their much more frequently developing secondary sexual characters than the females But the development of such characters would be much aided if the males were more liable to vary than the females—as I concluded they were—after a long study of domesticated animals Von Nathusius, who has had very wide experience is strongly of the same opinion [22] Good evidence also in favour of this conclusion can be produced by a comparison of the two sexes in mankind During the Novara expedition[23] a vast number of measurements was made of various parts of the body in different races and the men were found in almost every case to present a greater range of variation than the women but I shall have to recur to this subject in a future chap-

nat d by the m l s wh l are b i th sa cells

Es ys and Observations edited by O n v l. i. 1861 p 194

I f S l (Lehrb h der Bot l 18 0 s. 633) in p k g f th n l d f m l n proì t cell r m rks, erhält ich d e eine bei der l ere g g ct d nd e scl t bei d l erei

1867 ss. D W s- bach f m n u t d by D s. K Sel rz r a d Scl rz. O tl gre t r b l ty f th n l s f d m t ted m ls, see my I at f 1 mal nd I l nt nder D me t atio l. 1868 p 5

co q nn, ther males in battl r courtship, and thus l ving m ro progen are n the long run great than tl ose d n ed from rath m re pe fect adaptat t th ir cond tions f life W shall f rth see and it co ld ne have bee ant cipated th t the power to charm th f mal has som tim been m re important than th pow to co q e oth males in battle

Laws of Inheritance

th la of inh ritance as far as th are known. Tw d tinct l m ts are incl d d under th term inh ritance"—th transm ssion, and th d lopm nt f haract rs b t as these g rally go t th th di t nctı n is olt looked W see this distin ti n in those charact rs which are transmitted through th arly ears f lif b t are d l ped nly

both se es, tho gh d loped in lo Th t th y are prese t both se es, is mani fest wh t species, ha ing trongly marked

act rs prope to th male are occasi nally d loped in th f mal wh n sh grow ld o becomes diseased as, f nstance whe the comm h assumes th flowing tail feath rs, hackles, comb, purs, o ce and n p g nacit f th cock. Co rsel th sam thi g vid t, m re less plainl with castrated males. Again, nd pend tl f ld ag disease charact rs are occas nall trans rred from th mal t th f m l as wh n n ce tai breed f th f wl, purs regularl ppear th g and health f males. B t truth th are simpl d eloped in th f mal f m ev rs breed ach d tail in th tru ture f th p transmitted thro gh th f male t h mal offspring Man ases will h realt be gi n, wh re th f mal xhib ts, more o less perfectl haract rs prope to th m l n hom th must h been first d l ped, and th transf rred t th f mal Tl con- rse case of the first dev lopm t of char act rs th f mal and of transf re ce to th m le is less freq ent t will th ref re be well

to gi e one striki g instance W th bees the poll n-collecting apparatus is used by the f mal alone f r g th ring pollen f r the larve t n mo t of tl e pecies it i partiall de l ped n the males t wl m it is quite use- less, and it is perfectly de eloped in the males of Bombu o the h ll bee ᵃ As ot a si gle ther hymenopterous insect not e en th wasp which is closely all ed to the bee is pro- vided with pollen-collecting ppar t s, we ha e n grounds for pposi g th t male bees prim rdiall collected pollen as w ll as th f males altho gh we have some reason to pect that male mammals prim rd ally u kled th r young as w ll as th f males. Lastl in all cases of re rsi n, charact rs re transm tted through t o, three, or many m re g erati ns, and are th n de loped under certain nkn wn f rable cond ti ns. Tl s important d ti cti n between transmiss on and d lopm t will be best k pt ii mind l v th aid of th h potl esis of pang nesis. Ac- cord g to this h potl s, ry unit cell f th bod throws off gemmules r unde loped l ms, which are t ansmitted t tl e offspri g f both se s, and are multiplied by self divisi n. Th y m y remai und vel ped d ing th arly ars of l f o d ri g cess e ge erati ns and th r d lopment t un ts o cells, lik th se from which th y w re de- ri ed d pends th affi t s fo and mon w th th units r cells pre usly de l ped in th d ord r f growth.

th hand, a n w haracte ppears at ma turity o n d ring ld g t t nds to re ppear in th ff pri g t th same ad anced age. When d viat ns from this rule occur th transm tted characters m ch ft n ppear bef re than aft th corresponding g As I h e dw lt n this bject sufficiently in an th w k,ᵃ I w ll h re merely gi two r three nstances, f th sak f recalling th bject to th read mind In se al breed

nounced secondary sexual characters, such as brighter colours, greater size, strength, or pugnacity. With birds there has sometimes been a complete transposition of the ordinary characters proper to each sex; the females having become the more eager in courtship, the males remaining comparatively passive, but *apparently selecting the more attractive* females, as we may infer from the results. Certain hen birds have thus been rendered more highly coloured or otherwise ornamented, as well as more powerful and pugnacious than the cocks; these characters being transmitted to the female offspring alone.

It may be suggested that in some cases a double process of selection has been carried on; that the males have selected the more attractive females, and the latter the more attractive *males*. *This process, however, though it might* lead to the modification of both sexes, would not make the one sex different from the other, unless indeed their tastes for the beautiful differed; but this is a supposition too improbable to be worth considering in the case of any animal, excepting man. There are, however, many animals in which the sexes resemble each other, both being furnished with the same ornaments, which analogy would lead us to attribute to the agency of sexual selection. In such cases it may be suggested with more plausibility, that there has been a double or *mutual process of sexual selection; the more* vigorous and precocious females selecting the more attractive and vigorous males, *the latter* rejecting all except the more attractive females. But from what we know of the habits of animals, this view is hardly probable, for the male is generally eager to pair with any female. It is more probable that the ornaments common to both sexes were acquired by one sex, generally the male, and then transmitted to the offspring of both sexes. If, indeed, during a lengthened period the males of any species were greatly to exceed the females in number, and then during another lengthened period, but under different conditions, the reverse were to occur, a double, but not simultaneous, process of sexual selection might easily *be carried on*, by which the two sexes might be rendered widely different.

We *shall hereafter see that many animals* exist, of which neither sex is brilliantly coloured or provided with *special ornaments*, and yet the members of both sexes or of one alone have probably acquired *simple colours, such* as white or black, through sexual selection.

The absence of bright tints or other ornaments may be the result of variations of the right kind never having occurred, or of the animals themselves having preferred plain black or white. Obscure tints have often been developed *through natural selection for the sake of protection*, and the acquirement through sexual selection of conspicuous colours appears to have been sometimes checked from the danger thus incurred. But in other cases the males during long ages may have struggled together for the possession of the females, and yet no effect will have been produced, unless a larger number of offspring were left by the more successful males to inherit their superiority, than by the less successful; and this, as previously shewn, depends on many complex contingencies.

Sexual selection acts in *a less rigorous manner* than natural selection. The latter produces its effects by the life or death at all ages of the more or less successful individuals. Death, indeed, not rarely ensues from the conflicts of rival males. But generally the less successful male merely fails to obtain a female, or obtains a retarded and less vigorous female later in the season, or, if polygamous, obtains fewer females; so that they leave fewer, less vigorous, [illegible] gard to tructures ac [illegible]

[illegible]

of advantageous modification in relation to certain special purposes; *but in regard to* structures adapted to make one male victorious over another, either in fighting or in charming the female, there is no definite limit to the amount of advantageous modification; so that as long as the proper variations arise the work of sexual selection will go on. This circumstance may partly account for the frequent and extraordinary amount of variability presented by secondary sexual characters.

injurious, either by expending too much of their vital powers, or by exposing them to any great danger. The development, however, of certain structures—of the horns, for instance, *in certain stags*—has been carried to a wonderful extreme; and in some cases to an extreme which, as far as the general conditions of life are concerned, must be highly injurious to *the male*. *From this fact we* learn that the advantages which favoured males derive from

sexual d m larity nd complete l nt Instance h lready been gi e w th tl e breed f th f l and p geo and l r t re nal go case are comm n W th ani mal und r d m t t on, but wh tl n t I will t e ture t say n se m y lose cl aract s prope t it, and m y th s com som wh t to resemble th oppo t se f tance tl m l f s m breed f the f l h l t th masc l e tail pl m and hackl O the th l and th d ffere ces b twee tl sexes m v b creased u d r d m ti t on, as th m in sl eep n wh h th w h l t the h s. Ag in, cl act rs proper to se m y dd ly ppe r the th se as i th se b b eed f the f l which the h n acq re p nl bt y ung as ce tai P l sh b-b eeds, in wh ch th f m l as tl re reaso t be

g es f th y d pe d th g mm l f ce tai parts, alth gh prese t botl s, becomi g thr gh the nfl nce f d m t ca t n, eith d mant d l ped n th se

Th re is d fficult q t o wh h t will be co t to d f t f ture ch pt r m ly h th h act t first d l ped in both se s, could thro gh select be l m ted ts d l pm t t se l If f t ce b eed bserved th t som f l p geo (f h cl th charact rs ar ally t ansf rred an q al d gree t b th se) aried into p l bl co ld h by l g-co t ed selecti mak breed, wh ch th mal al l ld b f th t t, whil t th f m l mai ed hanged I w ll l ly say th t th s, th gh p h p t mposs bl w ld b t m l d ffi lt f tl t l lt f breed g from tl p l bl m les ld be to l g th h l tock f b tl se t th t t If h w ar t f th d ed ti t ppe ed wl l from th fi t lim ted th d l pm t t th male se th re w ld t b th l ast d ffi ult making b eed tl th t se f dif f re t col as deed l as bee ffected w tl B lgian breed which th m l l are treaked with black I m lar mann if any an t pp ared f mal p which was f m th first sexually l m ted t d l pm t to th f m l s, t w ld b asy to mak breed with th f m l l th charact rised b t if th ari t n was t

thus gi ally l mited the process w ul l be trem ly d ffic lt perhaps mpossible [n]

On the Relat n between th Period f De lopme t f a Cha t r d ts T ansmiss n to e Se to both S x s —Why certain char acters l ld be inl rited by botl se s, and othe charact rs b on sex alon nam ly by th t se n wl h tl e h racte first appeared n m t ases q it k wn. We an t

—

n ss, ... tl m l s l f fam ly and in an tl f m l by tl e f m l al tl gh in lotl case transm tted through th pposite as w ll as thro gh th sam se [n] Alth gh w ar th gn ant th two f ll ing rul s see oft t h ld good—that variati wh l first ppear in th r sex t al t period f l f t l t b de l ped n the sam se l whilst ar ati ns wh h first ppear arly lif in ther sex t nd t b de el ped in botl se es. I am l we far from ppo ng th t th is th sole d t mini g cause. As I h n t lsewhere d sc ssed thi bject, and it l as an mportant b ari g on sexual selection I m t h re t i to l gthy and somewl t int cat d tails

It in itself prob bl th t y charact ppeari g t an arly ag w ld t d to be inl rited q ally by both se s, f th se d t d ff m ch n const tutio b fore tl pow f reprod t gai ed O the otl er ha d aft tl po l as been gai ed and tl e sexes h com to diff r in co t t t tl

descr b g som ur us cas p geons, f tl

... ... ed is rem bl h w ry clos ly h uggested th right m thod of procedure.

R fere ces are gi my l riatio f Animal nd Pl nts nder D me ticat n, l. p 72.

of the fowl the down covered chickens the young birds in their first true plumage and the adults *differ greatly from one another* as well as from their common parent form the *Gallus bankiva* and these characters are faithfully transmitted by each breed to their offspring at the corresponding periods of life For instance the chickens of spangled Hamburgs whilst covered with down have a few dark spots on the head and rump but are not striped longitudinally as in many other breeds in their *first true plumage* they are beautifully pencilled that is each feather is transversely marked by numerous dark bars but in their

been transmitted to three distinct periods of life The pigeon offers a more remarkable case because the aboriginal parent species does not undergo any change of plumage with advancing age excepting that at maturity the breast becomes more iridescent yet there are breeds which do not acquire their characteristic colours until they have moulted two three or four times and these modifications of plumage are regularly transmitted

Inheritance at corresponding Seasons of the Year —With *animals in a state of nature* innumerable instances occur of characters appearing periodically at different seasons We see this in the horns of the stag and in the fur of arctic animals which becomes thick and white during the winter Many birds acquire bright colours and other decorations during the breeding season alone Pallas states [5] that

my

marked changes of colour that is from brownish cream-colour or reddish brown to a perfect white in several ponies in England Although I do not know that this tendency to change the colour of the coat during different seasons is *transmitted* yet it probably is so as all shades of colour are strongly inherited by the horse Nor is this form of inheritance as limited by the seasons more remarkable than its limitation by age or sex

Inheritance as Limited by Sex —The equal transmission of characters to both sexes is the commonest form of inheritance at least with those animals which do not present strongly marked sexual differences and indeed with many of these But characters are somewhat commonly transferred exclusively to that sex in which they first appear Ample evidence on *this head has been advanced in my work on Variation under Domestication* but a few instances may here be given There are breeds of the sheep and goat in which the horns of the male differ greatly in shape from those of the female and these differences acquired under domestication are regularly transmitted to the same sex As a rule it is the females alone in cats which are tortoise shell the corresponding colour in the males being rusty red With most breeds of the fowl the characters proper to each sex are transmitted to the same sex alone So general is this form of transmission that it is an anomaly when variations in certain breeds are transmitted equally to both sexes There are also certain sub breeds of the *fowl in which the males can hardly be distin*guished from one another whilst the females differ considerably in colour The sexes of the pigeon in the parent species do not differ in any external character nevertheless, in certain domesticated breeds the male is coloured differently from the female [36] The wattle in *the English carrier pigeon and the crop in* the pouter are more highly developed in the male than in the female and although these characters have been gained through long continued selection by man the slight differences between the sexes are wholly due to the form of inheritance which has prevailed for *they have arisen not from but rather in op*position to the wish of the breeder

Most of our domestic races have been formed by the accumulation of many slight variations and as some of the successive steps have been transmitted to one sex alone and some to both sexes, we find in the different breeds of the *same species all gradations between great*

n rst
m sticat n, vol. i. p 51 Also vol. ii p 71 f r a g ner l discuss n on Inh ritance as lim ted by Sex

which the males alon are horned and also the oung of a closely-allied species, the land (A oreas) in which both se es are horned. N w t is in trict conform t with our rul that in the young male koodoo, although ten months old, the horns w re remarkably small, consid ring the size ultimat ly attained b them whilst in the ung male land, al though onl three months old, tl horns were alread very much larger than in the koodoo. It is also noticeabl fact that in the prong horned ant lope[40] nly a few of the females, abo t one in fi ha e horns, and these are in rudimentary tate, though som times also four inches long, so that as far as concerns th possession of horns by the males alone, this species is in an intermediat conditi n, and the horns d not appear until about five or six months after birth. Th refore in comparison with hat little w kn w of the d lopm nt of the horns in other antelopes, and from what w d know with respect t the h rns of deer cattle, &c., those of th prong-horned antelope ppear at an int rmediat period of li.e,—that is, not very early as in cattle and sheep, nor ery la.e, as in the larger dee and antelopes. The horns of sheep, goats, and cattle which are w ll d loped in both se es, though not quite equal in size, can be felt, o n seen, at birth or soon afterwards. Our rul h w seems to fail in som breeds of sheep, f instance m rinos, in which th rams alon are horned for I cannot find on enquiry[41] that the horns are devel ped late in lif in this breed than in rdinary sheep in which both sexes are horned. B t th domesticated sheep the presence or absence of horns is not a firmly fixed character for a certain proportion of the m rino ewes bear small horns, and s me of the rams are hornles. and in most breed hornless wes are occasionally produced.

D W Marshall has lat ly made a pecial tudy of th protuberances so comm n on the h ads of birds,[42] and he comes t th f llowing conclusion —that w th those species in wh ch th y are confined to th males, they are de eloped late n lif wh reas with those pecies in which th are comm n to th two sex s, th y are d l ped t a ry early period Thus s certainly a triki g confirmati n of my tw law of inheritance.

In most of the pecies of the plendid family of the ph asants, the males diff r con picu ously from th f males, and they acquire their ornam nts at a rather late period of life The eared pheasant (C ossoptilon auri m) how ever offers a remarkabl exception, for both sexes possess th fine caudal plumes, the large ear tufts and the crimson el t about the head I find that all these charact rs ppear ry early in lif in accordance w th rule The adult mal can, h w ver be distinguished from the ad lt female by th presence of spurs and conformably with our rul these do not begin to be d eloped before the age of six m nths, as I am assured by M Bartlett, and n t this age th two sexes can hardl be distinguished.[43] The male and f male peacock diff con picuously from ach other in almost e ery part of thei plumage, except in the elegant head-crest, which is common to both sexes and thi is d eloped ery early in life, long before the other ornaments, which are confined to the male. Th wild-d ck off rs an analogous case for the beautiful green speculum on th wings is common to both sexes, though dulle and som what small in the female and t is d vel ped arly in life, whilst th curled tail-f athers and oth r ornam nts of the latter pecies they would ha bee d eloped earlier lif than in the commo peacock but M. H gt of Amsterdam informs me that th youn birds of the previous year of both pecies, compared April 23rd, 1869, there was no difference in the development of the spurs. The spurs, ho ever were as yet represe ted merel by slight knobs or ele a tions. I presume that I should have been informed if y difference in the rat of development had been observed ubseque tly

[40] Antilocapra Americana. I ha to thank Dr Canfield for information th respect t the horns of the female see also his paper in Procee in of the Zool. Society 1866, p. 109. Also Owen, Anatomy of Vertebrates, vol. iii., p. 627

[41] I have bee assured that the horns of the sheep north Wales ca always be felt, and are sometimes ev uch in le gth, at birth. Youatt says (... 1834 p ...), that the prominence of the fro tal b in cattle penetrates the c tis t birth, and that the horny mat er is soo formed er t.

I am greatl indebted t Prof. Victor Carus for ha ng made nquiries for me from the highest authorities, th respect t the merino sheep of Saxo y On the Guinea coast of Africa there is, how er breed of heep in hich, as with merinos, the rams alone bear horns and M W ood Reade informs me that e case observed by him, young ram, born on Feb. 10th, first shewed horns on March 6th, so tha in this n ance in conformity w th rule the dev lopme t of the horns occurred t later period of lif than in W lsh sheep, in hich both se es are horned.

[42] 'Über die knocherne Schadelhocker der Vogel' in the 'Niederland. Archiv fur Zoologie' Ba..

[43] ...

gemmules (if I may again use the language of pangenesis) which are cast off from each varying part in the one sex would be much more likely to possess the proper affinities for uniting with the tissues of the same sex and thus becoming developed than with those of the opposite sex

I was first led to infer that a relation of this kind exists from the fact that whenever and in whatever manner the adult male differs from the adult female he differs in the same manner from the young of both sexes The generality of this fact is quite remarkable it holds good with almost all mammals birds amphibians and fishes also with many crustaceans spiders and some few insects such as certain Orthoptera and Libellulæ In all these cases the variations through the accumulation of which the male acquired his proper masculine characters must have occurred at a somewhat late period of life otherwise the young males would have been similarly characterised and conformably with our rule the variations are transmitted to and developed in the adult males alone When on the other hand the adult male closely resembles the young of both sexes (these with rare exceptions being alike) he generally resembles the adult female and in most of these cases the variations through which the young and old acquired their present characters probably occurred according to our rule during youth But there is here room for doubt for characters are sometimes transferred to the offspring at an earlier age than that at which they first appeared in the parents so that the parents may have varied when adult and have transferred their characters to their offspring whilst young There are moreover many animals in which the two sexes closely resemble each other and yet both differ from their young and here the characters of the adults must have been acquired late in life nevertheless these characters in apparent contradiction to our rule are transferred to both sexes We must not however overlook the possibility or even probability of successive variations of the same nature occurring under exposure to similar conditions simultaneously in both sexes at a rather late period of life and in this case the variations would be transferred to the offspring of both sexes at a corresponding late age and there would then be no real contradiction to the rule that variations occurring late in life are transferred exclusively to the sex in which they first appeared This latter rule seems to hold true more generally than the second one namely that variations which occur in either sex early in life tend to be transferred to both sexes As it was obviously impossible even to estimate in how large a number of cases throughout the animal kingdom these two propositions *held good* it occurred to me to investigate some striking or crucial instances and to rely on the result

An excellent case for investigation is afforded by the deer family In all the species, but one the horns are developed only in the males though certainly transmitted through the female and capable of abnormal development in them In the reindeer on the other hand the female is provided with horns so that in this species the horns ought according to our rule to appear early in life long before the two sexes are mature and have come to

sex alone in which they first appeared in the progenitor of the whole family Now in seven species belonging to distinct sections of the family and inhabiting different regions in which the stags alone bear horns I find that the horns first appear at periods varying from nine months after birth in the roebuck to ten twelve or even more months in the stags of the six other and larger species But with the reindeer the case is widely different for as I hear from Prof Nilsson who kindly made enquiries for me in Lapland the horns appear in the young animals within four or five weeks after birth and at the same time in both sexes So that here we have a structure developed at a most unusually early age in one species of the family and likewise common to both sexes in this one species alone

In several kinds of antelopes only the males are provided with horns whilst in the greater number both sexes bear horns With respect to the period of development Mr Blyth informs me that there was at one time in the Zoological Gardens a young Koodoo (*A* *st epsiceros*) of

I am m [illegible] bliged t Mr C [illegible] pl [illegible] ng m d [illegible] es f [illegible] r nd t th [illegible] ebuck [illegible]

ale [illegible] f N Am rica see *Land* [illegible] *d W* [illegible] 1868 pp 221 [illegible] 254 [illegible] d f th *C* [illegible] [illegible] *nd C* [illegible]

p geon, descr bed by Ne m te " wh h b th se s ch g tl col r d n g tw r th ee m ult (as l kew e th case w th the lm d t mbl r) n ertheless, these ch g s, th gh occ rring ath r late in l f ar com m to both se e On ar ety of the canary b d nam ly th London P e ff s a nearly an l g ase

W th th b eeds of the f wl the nl ritance f ar us charact rs by r b th se seem g ally d t m ed by the pe od t l ch h cha acters e d v l ped Tl n all th many b eeds wh ch th ad lt m l d ff s gre tly i colo f m th f mal as ll from th wild pa t p he diff rs

arly th sam m nn as th pare ts, and

can be manifes

pec l ar black wh t pl m ge wh h l ad to ts t ansf t both sex f the m l l f m y t l pecu a th black wh t tl f m l b g d ff tly col ured W th th so-c lled Koo sub-b eed f tl f wl l h th f th re t sely pe lled w th d k t p s, b th se es and th ch k l red n ly th sam m nn Th laced pl m g f the Seb ght bantam th sam both se s, and

sembl ach th m l sely than d th se f th abo gi al p t pec y t th y acq re ther haract ri t plum g l t n ld f th l k ns d ti tly pe lled W th pect t tl l aract b d col ur in th ld p t pec d m t f the d m t b eds, tl m l l po sess ll-d l ped comb b t th y g f th Spam h f wl t l g l d l p d t ry lv g and accordan th th ly d l pm t tl m l t f l ze tl adult f m l I tl g m b eed p g ac t d l ped t w d rf lly ly g

of wl cl curi u proofs could be g en and tl is cl aract r st s tted to b tl se s so tl t th h n from th e treme pugnac ty re n w g er lly xl b ted n epa ate pe With th *Polish breeds* th bo y pr t berance of tl e k ll wh h uppo ts tl c st is part ally de el pede nbef etl cl i k a l at led d the cre t t lf soo beg ns t g ow though t fir t feebly and tl br ed tl ad lt f b th se s ar ch act ised by a gre t bony p otub n e and nme se c e t

F lly f m wh t w ha e n w seen f tl e r lat n wl h ts in many tural specie and d m t ted ac s, b tw en th period f th d el pme t f th r ch acte and tl ma r f th tra m ss n—f r xample th t k g fact f tl e ly growtl of tl e horn the rei dee i wl cl both e s bear h rns in c mp rison w tl th i m l l te gro th in th th pecie n wl h the male l bears h rn—w may co l de tl t e th gh t th sol use f characte s b ng l ly l nted by e se is ther d l pm t t lat ge And seco dly f

It ppears, h w th t som d ff nce mu t n t b twee th se n lun g a ve y arly mb y period f charact s d l ped t th g t ar ly becom attached to sex

Summ y d conclud g rema k—Fr m th f g g d sc n ntl ar l w f inh ritan w l tl t th ch act s f the pare ts ft n, n g ally tend to be-com d el ped th ff p g f th sam sex, t th ame g d period cally at th sam ason f th ye n wh h they fi t ppeared n the p ts. B t tl se r l s w g to kn wn e far f m b g fi ed H n d ri g th mod ficat n f pec tl ocess e chang m y ad ly b t an m tt d d ff t y som t o d som to b th som to th ff p g t n g a d som to th ff pri g t ll g N t ly th l w of h tance trem ly complex, but

und th be d f each pec

Das G nze der T benzu ht 1837 ss. 21 24 F th case of th treaked p geons, see D Ch p is, Le P g Voyageu Belg 1855 p 87

the male are developed lat as t

u u t ie characters follow our two rules in their order of development

As most insects emerge from the pupal state in a mature condition it is doubtful whether the period of development can determine the transference of their characters to one or to both sexes But we do not know that the coloured scales for instance in two species of butterflies in one of which the sexes differ in colour whilst in the other they are alike are developed at the same relative age in the cocoon Nor do we know whetl

aiks are confin hilst nce not so improbable as it may at first appear for with the Orthoptera which assume their adult state not by a single metamorphosis but by a succession of moults the young males of some species at first resemble the females and acquire their distinctive masculine characters only at a later moult. Strictly analogous cases occur at the successive moults of certain male crustaceans

We have as yet considered the transference of characters relatively to their period of development only in species in a natural state we will now turn to domesticated animals and first touch on monstrosities and diseases The presence of supernumerary digits and the absence of certain phalanges must be determined at an early embryonic period—the tendency to profuse bleeding is at least congenital as is probably colour blindness—yet these peculiarities and other similar ones are often limited in their transmission to one sex

ly th o x s ts full f h k as cas ccord ng to ur ul With tl ll d M gu ucullatus have how r cas f th k nd the t e es d ff r con p cu usly n g n l plum g d to a con d r bl d r ee

so that the rule that characters developed at an early period tend to be transmitted to both sexes, here wholly fails But this rule as before remarked does not appear to be nearly so general as the converse one namely that characters which appear late in life in one sex are transmitted exclusively to the same sex From the fact of the above abnormal peculiarities becoming attached to one sex long before the sexual functions are active we may infer that there must be some difference between the sexes at an extremely early age With respect to sexually limited diseases we know too little of the period at which they originate to draw any safe conclusion Gout however seems to fall under our rule for it is generally caused by intemperance during manhood and is transmitted from the father to his sons in a much more marked manner than to his daughters

In the various domestic breeds of sheep goats and cattle the males differ from their respective females in the shape or development of their horns forehead mane dewlap tail and hump on the shoulders and these peculiarities in accordance with our rule are not fully developed until a rather late period f life The sexes of dogs do not differ except that in certain breeds e pecially in the Scotch deer hound the male is much larger and heavier than the female an l as we shall see in a future chapter the male goes on increasing in size to an unusually late period of life which according to rule will account for his increased size being transmitted to his male off pring alone On the other hand the tortoise shell colour which is confined to female cats, is quite distinct at birth and this case violates the rule There is a breed of pigeons in which the mal s alone are streaked with l lack and the streaks can be detected even in the ne tlings but they become more conspicuous at each succes ive moult, so that this case partly opp es and partly supports the rule With the Engl h carrier and pouter pigeons the full developement of the wattle and the crop oc urs rather late in life and conformably with the rule these characters are tran mitt d in full perfection to the males alone The foll ing cases perh ps come within th class previ u ly alluded to in which both sex s have varied in the same manne at a rather late period of l fe and hav onse u ntly transf d their new ch r act s to both sexes at a orre pon ling l te period an l if so these cases ar not opposed to o rule —there exist ub-l ls of the

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p geon, described by N um t r[a] in wh h both sexes change tl e r col ur duri g tw r three m ults (as i likewise th case with th alm d t mbl) n rth l ss, th se ch g s, th gl occ rn th l t n l fe are com m to both sexes. O e ariety f the canary b rd nam ly th Lond n Prize off rs nearly an l g s case

W th tl breeds f th f wl the inh ritance f ario s charact by n or botl se s, seem g n rally d termined by th period at hich ch charact rs e d l ped Thu in all th many breeds n wh ch th ad lt mal diff rs gre tly n colo from th f m l as ll from th wild p t pec es, h diff rs

m t f th breed wh ch the tw se s ser ll ach th the y ung are col ed n

l ad t ts transf re ce t both se f th m l al f many t l pe ar the black whit tl f mal b g diff re tly col red W th th so-called koo b-breed f the f wl wl h th f tl rs are trans sely p lled w th d k tripes, both se and th chi k are col red in ea ly th sam m nn Th laced plum g f th Seb ght bantam th sam both se s, and

sembl ach th m re l sely th d th se f tl bo g al p re t pec y t th y acq th charact n t pl m g l t hf f th b k ns d ti tly pe called W th re pect t th charact rs be d col in th w ld par t spec d m t f th d m t breeds, tl m l l possess ll-d l ped comb b t th y g f th Span h f l t larg l d l ped t ry arl ag and accordance w th th arly d l pm t th mal t f us al size tl ad lt f mal I th gam breeds p g ac t d loped t d rf lly ly ag

of wh cl un u proofs co ld be g a l tl i charact r s t ansm tted to both sex s, so that the h ns, from the trem p gnacity re w g rally h bited in separ t pe s. With th l l sh breeds the bo y protube ance of tl kull which s ppo ts the re t i part lly d lopede n bef re th l ck ns rel t l ed d th cre t itself soon beg ns to grow th ugh t first feebly[a] and i thu b ed th ad lt of both se are cha cterised by a gre t bo y prot b ance and an immense c est

F ally from wl t w h n w seen f th rel t n wl h i ts n many n tur l spec e and d me t ted races, between th period f the de l pm nt of their characte s and th man e f th i transmiss n—f r xample the trik g fact f th arly growth of tl e h rns tl re ndee i wh cl both se s be r h rns, n comparison w tl th i m cl l te growth in the th r pecie n wl ch th male al e b ars h rn —w m y co l de th t e th gh n t th sol c use f haracte be g cl si ly l rited by e se s th r de l pm t at a l t ag And seco dly th t o tho gh pparently l ss ffici t ca se f charact rs be g nherited by botl sex s, s th d l pme t t an rly g whilst th se diff but l ttl constit t on. It ppears, h w that some d ffe ce mu t xi t bet een the se n duri g a y e ly emb period fo haract s d l ped t thi t ar ly becom ttached to se

S mm y d lud g cma ks—From th f reg ing disc ss n n th ari l w f inh ritance w l arn tl t th ch act f th par ts ften, en g ally t nd t be-com d el ped in th off pring f th same sex, t th sam g and period cally t the sam seaso f th y ar wh h th y first ppeared n th parents. B t th se rul s, wi g to unkn wn c uses, are far from b g fi ed H ce during th mod ficati f peci s, th ccess chang m y ad ly be t ansm tted d ff re t w y som t sex, and some to b th som t th ff p g t n and som t th ff pri t ll g s. N t nly a th laws f inh ritance trem ly compl b t

Das Ganze der T ben. *M* 1837 ss. 21 24 F the case of th streaked p geons, see D Chapuis, *Le P g Voyageu Belge*, 1865 p 87

so are the causes which induce and govern variability The variations thus induced are preserved and accumulated by sexual selection which is in itself an extremely complex affair depending as it does on the ardour in love the courage and the rivalry of the males, as well as on the powers of perception the taste and will of the female Sexual selection will also be largely dominated by natural selection tending towards the general welfare of the species Hence the manner in which the individuals of either or both sexes have been affected through sexual selection cannot fail to be complex in the highest degree

When variations occur late in life in one sex and are transmitted to the same sex at the same age the other sex and the young are left unmodified When they occur late in life but are transmitted to both sexes at the same age the young alone are left unmodified Variations however may occur at any period of life in one sex or in both and be transmitted to both sexes at all ages and then all the individuals of the species are similarly modified In the following chapters it will be seen that all these cases frequently occur in nature

Sexual selection can never act on any animal before the age for reproduction arrives From the great eagerness of the male it has generally acted on this sex and not on the females The males have thus become provided with weapons for fighting with their rivals with organs for discovering and securely holding the female and for exciting or charming her When the sexes differ in these respects it is also as we have seen an extremely general law that the adult male differs more or less from the young male and we may conclude from this fact that the successive variations by which the adult male became modified did not generally occur much before the age for reproduction Whenever some or many of the variations occurred early in life the young males would partake more or less of the characters of the adult males and differences of this kind between the old and young males may be observed in many species of animals

It is probable that young male animals have often tended to vary in a manner which would not only have been of no use to them at an early age but would have been actually injurious—as by acquiring bright colours which would render them conspicuous to their enemies or by acquiring structures, such as great horns, which would expend much vital force in their development. Variations of this kind occurring in the young males would almost certainly be eliminated through natural selection With the adult and experienced males, on the other hand the advantages derived from the acquisition of such characters, would more than counterbalance some exposure to danger and some loss of vital force

As variations which give to the male a better chance of conquering other males or of finding securing or charming the opposite sex would if they happened to arise in the female be of no service to her they would not be preserved in her through sexual selection We have also good evidence with domesticated animals that variations of all kinds are if not carefully selected soon lost through intercrossing and accidental deaths Consequently in a state of nature if variations of the above kind chanced to arise in the female line and be transmitted exclusively in this line they would be extremely liable to be lost If however the females varied and transmitted their newly acquired characters to their offspring of both sexes the characters which were advantageous to the males would be preserved by them through sexual selection and the two sexes would in consequence be modified in the same manner although such characters were of no use to the females but I shall hereafter have to recur to these more intricate contingencies. Lastly the females may acquire and apparently have often acquired by transference characters from the male sex

As variations occurring later in life and transmitted to one sex alone have incessantly been taken advantage of and accumulated through sexual selection in relation to the reproduction of the species therefore it appears, at first sight, an unaccountable fact that similar variations have not frequently been accumulated through natural selection in relation to the ordinary habits of life If this had occurred the two sexes would often have been differently modified for the sake for instance of capturing prey or of escaping from danger Differences of this kind between the two sexes do occasionally occur especially in the lower classes But this implies that the two sexes follow different habits in their struggles for existence which is a rare circumstance with the higher animals The case however is widely different with the reproductive function in which respect the sexes necessarily differ For variations in structure which are related to these functions have often proved of value to one sex and from having arisen at a late period

of lif ha been t ansm tted t n sex alo and such ariati s, thus p ese ed and trans mitted ha e gi n rise to seco dary se u l characters.

In th foll wing chapters, I hall treat f the secondary sexual characters in animals f all classes, and shall e d a ur in each case t pply th pri ciples plai ed n tl prese t ch pte Th l w st classes w ll d tain u f rv sh rt tim b t tl higl animals, pe- ciall birds, m t be tre ted at consid able l gth It h ld be b rn m d that f r

w th most intere ti g

Supplement on the proportional numbers of the two sexes in animals belonging to various classes

As n e, as far as I can d sco e has paid att t to th rel ti n mb rs f th tw se thro gh t th animal kingd m I will h re gi such m terial as I h been abl to collect, alth gh th y are t m ly imperfect. Th consist in only f w instance f actual um ti n, and th numb rs are n t ry larg As th proporti ns are kn wn w th ce tainty nly n manki d I will first gi e th m as tandard of comparison.

M n.—I E gland during ten y ars (from 1857 to 1866) th er g numb r of children born ali y arly was 07 1 0 in th propo t f 104.5 mal t 100 f mal s. B t in 1857 the male b rths thro gh t E gland w re as 105 2, and 186 as 104 0 t 100 Looki g t separate d tricts, in B cki ghamshire (wh re abo t 000 childre are ann ally born) th *me* proporti f mal to f mal births, d g th wh l period f th abo t n y ars, was as 102 8 to 100 wh lst N Wales (wh re th ag annual b rths are 12,8 3) t was as high as 106 to 100 Taki g till mall dis- trict, z. R tlandshire (wh re th ann al b rths ag nly 39) 1864 th mal b rths w re as 114 6 and in 1862 as nly 97 0 t 100 b t in this small distri t th g f th 385 b rths d ri g th wh l t years, was as 104.5 to 100 that n th sam

100 but during this pe ... times in departme t, and six time in another that the female b rth l exceeded th mal s. In Russia tl e a erage propo t n is as high as 108 9 and in Philad lph a n tl e United State as 110.5 to 100 The a r g f Europe deduced by Bicke from abo t se ty mill n b ths, is 106 males to 100 f mal s. On th othe l nd w th wh t cl ldren born at tl C pe of Good Hope, the propo ti f males is so low as t fl t te luring ccessi y ars between 90 and 99 males f r e ry 100 f mal s. It is si gular fact tl t w th Jews the proporti n f male births s decidedly larg than with Christian th s Prussia tl propo t on is as 113 Breslau as 114 and in Li ni as 120 to 100 th Chris- tian b rths these countri s be ng tl sam as usual fo nstance in Li onia as 104 to 100 [50]

Prof F ye remarks that a till greate pre- po d rance of males would be n t w th if d th truck both se es in eq al proporti n in th w mb and duri g b rth. But the fact is, th t f ry 100 till born f males, w ha n se ral countri from 134 6 to 144 9 till born males. During tl first f ur r fi e y ars f life also, m re m le children d e than fe- mal s, f r example n England d ring th first y ar 126 boys d f r ry 100 gi ls—a pro- po ti n which n F ance is t ll m re unfa abl D Stockt H gh accou ts for

P oductio de S xe 1863 p 25

British nd Foreig Medico-Ch g Review April 1867 p. 343 D St k lso rem k (T th Ann al Reports f B rths D ath d S otl nd 1867 p. xx iii.) that "These amples m y uffice t sh w th t, t lmost ry tag of life, th males Scotla d h greate liability to death d

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i jui ous But the size of the body and e peci ally of the head being greater in male than female infants is another cause for the males are thus more liable to be injured during par turition Consequently the still born males are more numerous and as a highly competent judge Dr Crichton Browne [52] believes male infants often suffer in health for some years after birth Owing to this excess in the death rate of male children both at birth and for some time subsequently and owing to the ex posure of grown men to various dangers and to their tendency to emigrate the females in all old settled countries where statistical rec ords have been kept [53] are fo ... der

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and climates in Naples Prussia, Westphalia, Holland France England and the United States the excess of male over female births is less when they are illegitimate than when legi timate [54] This has been explained by different writers in many different ways as from the mothers being generally young from the large proportion of first pregnancie &c But we have seen that male infants from the large size of their head suffer more than female in fants during parturition and as the mothers of illegitimate children must be more liable than other women to undergo bad labours, from various causes such as attempts at conceal ment by tight lacing hard work distress of

high r d ath t th n th fem l s The f ct how e e f thi p cul ar ty b g m t stro gly de- v l ped t th t if it l p od of l f wl i th d ss food d g i al treatm nt f b th e re l k s m t pro that the higl r male de th r t i mp ssed n tur l a d con tit t n l pecul ty d t s l n

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mate With most animals the greater size of the adult male than of the female is due to the stronger males having conquered the weaker in their struggles for the possession of the fe males, and no doubt it is owing to this fact that the two sexes of at least some animals differ in size at birth Thus we have the cur us fact that we may attribute the more frequent deaths of male than female infants e pecially amongst the illegitimate at least in part to sexual selection

It has often been suppo ed that the relative age of the two parents determine the sex f the off pring an l Prof Leuckart[55] has adva iced what he con iders sufficient evidence ith respect to man and certain domesticated ani mal that this is one important though not the sole factor in the result So again the peri l of impregnation relatively to the state of the female has been thought by some to be the efficient cause but recent observations dis countenance this belief Accordin t Dr Stockton Hough [56] the season of the year the poverty or wealth of the parents residence in the country or in cities the crossing of f reign immigrants &c all influence the proportion of the sexes. With mankind polygamy has also been suppo ed to lea l to the birth f a greater proportion of female fa t I t D

as from monogamous unions Hardly any ani mal has been rendered so highly polygamous as the English race hor e and we shall imme li ately see that his male and female off pring are almost exactly e qual in number I will now give the facts which I have collected with re- pect to the proportional numbers of the sexes of various ani als and will then briefly dis cu s how far selection has come into play in determining the re ult

Hor s s —Mr Teg tmeier has been so kin l as to tabulate for me from the *Racing Cal ndar* the births of race horses luri g a period of twenty one years, viz from 1846 to 186 1849 bei g omitted as no returns were that

[55] *Le ck rt i W b H ndwo terbuch der Phys.* 1853 s 774

[56] *Soc al Sci nc I soc at f Ph l d lph* 1874.

[57] *Anth polog al Review* April, 18 0 p cviii.

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y ar p blished The total b ths we ... 560 [14] consist g f 1 63 mal and 1 97 fem l s, in the propo ti n f 99 mal s t 100 females. As these n mbe s ar t l bly larg and as th y are drawn from ll parts f E g land, during se al y rs w may w th m cl) d th t w tl tl e dom tic

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lated are cons d red tl n ... ho ses w as 10 1 1 m 1867 as d 9 6 to 1 ... m 1 I tl tab lated t s tl prop cee and th f mal ... periods ach ff y ars thi l m be acc d tal t l ast I can d tect th g f th kind with man in th decenni l t bl th *Registrar s Report f 1866*

D g —During period of tw l rs, from 1857 to 1868 th b tl f l g n mb f greyl unds thro gh t E gland w re se t t th *F ld* w p pe d I m gai d bted to M T g tm e f caref lly t b la ting th ults. Th ecorded b rth re 68 8 cons ti g f 360 mal and 3 3 f m l s, th t s, in tl proport f 110 1 m l to 100 f m l Th gre t t fl t t ns occurred 1

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f m les ere bo n, and 794 mares f ded.

astr ted so th t tl e f llo ing returns d n t gi tl e propo t ons t bi tl M co e I find th t se al g t breed rs n Scotla l wl o tl ar l leep e f n l

in ... som l t larg r t b tl tl an at the ... re ark bl co c d n e

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heep ch fly *Le ce t rs*, d ring ... to xteen y ars th y am unt all g tl r t 896 b rths, co sisti g of 4407 mal and 4 8 femal th t i in th propo ti n of 96 7 n l s t 100 f m l s. W th re pect t Cl evi t and black faced heep b ed in Scotland I l a e rece ed returns from ix breed s, tw f tl e n n larg seal ch fly f th year 186 1869 b t some f the ret rn t d back t 1862 The total n mb r recorded amo nts to 0 685 cons ti g f 071 m les nd 25 614 fen ales r n th proport on f 97 9 males to 100 f mal s. If w take the E gl sh and Scot h t nst g th r th t tal n mber am ts t 9 690 consisti g f 29 4 8 mal s and 30 172 f m l s, as 97 7 t 100 So th t with heep f t t the f mal s are ce

th se con is ce ... al n the proport f 94 4 mal t 100 f m l Th R W D F nf rms me that n 1867 t f 34 cal born f rm n D bysh nly was b ll. M Har so W has q red from se al b eed s f *l g* and m t f th m t mat th mal to th f mal b rth as b t t 6 Th same

comm n t, I h rece ed co fl ting t t

I m m ch d bted t M C pples f h g procured f m th bo tur from Scotl d as ll som f th f llo g retur catt] M R. Ell t, f La gh ood first called my tt t t th prem ture d ths f th males,— tat m t b que tly confi med by M A tchiso d th rs. T tl is l tt g tl m d t M P yan I my thanks f larg returns as t heep

ments Mr R Elliot of Laighwood informs me that a rat catcher assured him that he had always found the males in great excess even with the young in the nest In consequence of this Mr Elliot himself subsequently examined some hundred old ones and found the statement true Mr F Buckland has bred a large number of white rats and he also believes that the males greatly exceed the females In regard to moles it is said that the males are much more numerous than the females [60] and as the catching of these animals is a special occupation the statement may perhaps be trusted Sir A Smith in describing an antelope of S Africa[61] (*Kobus ellipsiprymnus*) remarks that in the herds of this and other species the males are few in number compared with the females the natives believe that they are born in this proportion others believe that the younger males are expelled from the herds and Sir A Smith says that though he has himself never seen herds consisting of young males alone others affirm that this does occur It appears probable that the young when expelled from the herd would often fall a prey to the many beasts of prey of the country

BIRDS

With respect to the *Fowl* I have received only one account namely that out of 1001 chickens of a highly bred stock of Cochins, reared during eight years by Mr Stretch 487 proved males and 514 females i e as 94 7 to 100 In regard to domestic pigeons there is good evidence either that the males are produced in excess or that they live longer for these birds invariably pair and single males as Mr Tegetmeier informs me can always be purchased cheaper than females Usually the two birds reared from the two eggs laid in the same nest are a male and a female but Mr Harrison Weir who has been so large a breeder says that he has often bred two cocks from the same nest and seldom two hens moreover the hen is generally the weaker of the two and more liable to perish

With respect to birds in a state of nature Mr Gould and others are convinced that the males are generally the more numerous and as the young males of many species resemble the females the latter would naturally appear to be the more numerous Large numbers of pheasants are reared by Mr Baker of Leadenhall from eggs laid by wild birds and he informs Mr Jenner Weir that four or five males to one female are generally produced An experienced observer remarks[63] that in Scandinavia the broods of the capercailzie and black cock contain more males than females and that with the Dal ripa (a kind of ptarmigan) more males than females attend the *leks* or places of courtship but this latter circumstance is accounted for by some observers by a greater number of hen birds being killed by vermin From various

and I have been assured that this is the case in Scotland Mr Weir on enquiring from the dealers who receive at certain seasons large numbers of ruffs (*Machetes pugnax*) was told that the males are much the more numerous This same naturalist has also enquired for me from the birdcatchers who annually catch an astonishing number of various small species alive for the London market and he was unhesitatingly answered by an old and trustworthy man that with the chaffinch the males are in large excess he thought as high as 2 males to 1 female or at least as high as 5 to 3 [65] The males of the blackbird he likewise maintained were by far the more numerous, whether caught by traps or by netting at night These statements may apparently be trusted because this same man said that the

net the females preponderate greatly but unequally during different years during some years he has found the females to the males as four to one It should however be borne in mind that the chief season for catching birds does not begin till September so that with some species partial migrations may have begun and the flocks at this period often consist of hens alone Mr Salvin paid particular attention to the sexes of the humming birds in

[60] Bell, *History of British Quadrupeds* p 100

[61] *Illustrations of the Zoology of S Africa* 1849 pl 29

[62] Brehm (*Illust Thierleben* B iv s. 990) comes to the same conclusion

[63] On the authority of L Lloyd *Game Birds of Sweden* 1867 pp 12 132

[64] ... *Hist ... of Selborne* ... xxi ... ed of 1825

tl 40 ml l ff l s. Il g teat mber ght by ngl day 0

Ce tral Am ri a, and s con inced th t with most of th pecies th m les are n cess thus ar he proc red 04 pecim ns belonging t t pecies, and these consisted of 166 mal and f only 38 f m l s. W th two th r species th f mal were i xcess b t tl proport ns pparentl tl r dur g diff re t seasons l lfe t local t es f occasi th mal f *Campylopt rus hem leucurus* w t th f m les as t 2 and an th occas n e actly th re rsed ratio. As bearing n thi latte po nt, I may add that Mr P wy f und i Co fu and Epirus the se es f tl ch ffinch keep ng part, and th f m l b far th mo t nu m rous whilst i I al ti M Trist am f nd th male flocks ppearing gre tly to ceed th fem l mbe So gai with th *Q is alus maj* M G T l says, th t *Fl rid tl re w re ry f w f m les* propo ti t th mal s, whilst H n d as the p portı was tl th w the pecies th re h g th ha act f polyga mı t.

Fish

are many difficult in a ri g t any just co lusi Inf rt l f m l m ght read ly be mistak f males, as D Gü the has re marked to m n regard t tro t W th some peci th mal are b h ed t di soon aft r f tilisi g th a. W tl many peci th m les are f mu h mall tl n th females, so tl t larg umbe f mal wo ld scape from th sam t b wh h tl f m l w re ght. M C bonn wh has specially ttended to th n t al hi t y f th pik (*Es lucius*) t tes th t many mal s, wi g t th ir mall iz are d red by the larg f mal and h beh th t th m les of alm t all fish re posed from this sam se to greate dang than th f males. N rth l ss, in tl f w cases in wl ch th proporti al mbers h bee t ally b se ed th mal ppe t be larg l in e cess. Tl s Mr R Bu t, th uperint nde t of t tb ll xperim nts, sa s tl at in

female Afterward females ufficie t i r btaining a were procured He adds, from th great proporti n of the mal s, th y are con tantly fighting and tean g eacl th r n tl e pawning beds. Thus di propo l no d ubt, can be accounted fo n part, b t wl ther wholly is d ubtf l by the males ascend g th ri ers before the females. Mr F B kland remarks in reg rd t trout, that t s a curi us fact th t the males preponde te y larg ly mb o r th females. It arably l p-

mal s to e

q te account f tl tl r tl males are m re num rous than tl e f m les, tl l tt r seek saf ty by concealm t th than fi gl t H tl n adds, tl t by c ref lly searcl g th banks uffici t f mal s for btaini g o a an be f und Mr H Lee of rm m th t o t of 212 tro t tak n f thi purpose in Lord P tsm uth s park, 1 0 w re mal and 6 f m les.

Th males of the Cyprinidæ lik wise seem to be in cess b t se al m mbers f this f m ily iz th arp tench bream and m nn w ppear reg larly to f ll w the p actice rare in th animal ki gd m of pol andry fo the f mal whilst sp wning al ys att nded by tw males ach sid and the ase f the bream by three r f ur mal s. Th fact is so w ll k wn th t t alw y recomm nded t tock pond w th tw male t ches t ne f male, r t l ast w th three males to tw females. W th th m nn w an cell t bser e tat s, th t n th spa ni g bed th mal are ten tim s as num ro s as tl f m l wl n f mal com m t th mal s, h immed t ly pressed lo ly by mal ach sid and wh th y h been n tl t t t f a tim are perseded by the tw m l s.

INSECTS

In this great class the Lepidoptera almost alone affords means for judging of the proportional numbers of the sexes for they have been collected with special care by many good observers and have been largely bred from the egg or caterpillar state I had hoped that some breeders of silk moths might have kept an exact record but after writing to France and Italy and consulting various treatises I cannot find that this has ever been done The general opinion appears to be that the sexes are nearly equal but in Italy as I hear from Professor Canestrini many breeders are convinced that the females are produced in excess This same naturalist however informs me that in the two yearly broods of the ailanthus silk moth (*Bombyx cynthia*) the males greatly preponderate in the first whilst in the second the two sexes are nearly equal or the females rather in excess

In regard to butterflies in a state of nature several observers have been much struck by the apparently enormous preponderance of the males [4] Thus Mr Bates [5] in speaking of several species about a hundred in number which inhabit the upper Amazons says that the males are much more numerous than the females even in the proportion of a hundred to one In North America Edwards who had great experience estimates in the genus Papilio the males to the females as four to one and Mr Walsh who informs me of this statement says that with *P turnus* this is certainly the case In South Africa Mr R Trimen found the males in excess in 19 species [6] and in one of these which swarms in open places he estimated the number of males as fifty to one female With another species in which the males are numerous in certain localities he collected only five females during seven years In the island of Bourbon M Maillard states that the males of one species of Papilio are twenty times as numerous as the females [7] Mr Trimen informs me that as far as he has himself seen or heard from others it is rare for the females of any butterfly to exceed the males in number but three South African species perhaps offer an exception Mr Wallace[8] states that the females of *Ornithoptera croesus* in the Malay Archipelago are more common and more easily caught than the males but this is a rare butterfly I may here add that in Hyperythra, a genus of moths Guenée says, that from four to five females are sent in collections from India for one male

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[5] *Th N t al t n th Amazons* v l i 1863 pp 228 347

F u f thes ase are g n by Mr T me i n his *Rhopalocer Afri a Aust alis*

[7] Quoted by Trim T *act ns f th Ent. Society* v l v part iv 1866 p 330

[8] *T act I n Society* l x p 37

I oc d g I to ological Society F b 17 1868

[10] Q ted by Dr W llace n *I oc d g Ent mological Society* 3rd se es, v l 1867 p 487

many breed rs in Italy that th f mal t r pilar of th silk m th ff rs m re from th rece t disease than th male and Dr Sta dinge inf rms m th t in rearing Lep d pt ra ~ l l th cocoon than mal s.

males. ...

was then practice b t D Wallace is re t collect rs t k all th pecim ns

abl d ur th largest and Professor Can strini inf rms m th t in Italy some breed rs beli e, tho gh n ns ffici t d nce that in th first broods f th ailanthus s lkm th, th wasps destro larg numb of the female than of th mal cat rp llars. D Wallace furth remarks th t f mal caterpillars, from being larg than th males, require m re tim for their d l pm t, and consum m re food and moisture and thu th would be xposed d rin longer tim to dan er from ichneu mons, birds, &c., and tun f scarcity w uld perish in greate numbers. Hence t ppears quite possible that in tate of nature, f w f mal Lep d pt ra may reach maturity than males and f pecial bject w are concerned with th ir relati numbers t m t nt wh n th se es are read to propag t the kind

g ce of th male from th ir cocoons. Mr tainto inf rms m that from tw l to tw t males, may often be seen co gre ted ro nd f male *Elachista rufocinerea.* It well known that if virgin *Lasiocampa quercus* Sat rn carpi be exposed in a cage ast umbers f males collect round h and if confined room will com d wn th chim ne t he Mr D bled beli es that h has see from fift t h ndred males of both these peci attracted in th course f si gle d b femal in confin m t. I th I le f Wight Mr Trimen xposed a bo wh h f mal of th Lasiocamp had bee confi ed th pre us da and fi males soo n d ored t gain admittance I A stralia, Mr V rreaux, ha ing placed th f male of a small Bomb x in a bo n l pocket, was f l lowed l y crowd f males, so that about 200 ent

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of th f ma as ...

entl nd t s tl t rsel tl mal ceed th f mal in th sam proportin. About 000 pecies r arr ti s f m this (Het rocera) are cat l gued tl se th w l ss f males bein, here e l ded n acco t f th d ff r nce hab t between tl e tw se e f tl se 000 pecies, 141 d ff in price acc rd g to sex, the mal f l 0 be cl eape f those f nly 11 be g d re tl an tl f m les. Th ra price of th m l f th 1 0 pecies, to th t f the f males, as 100 to 143 W th re pect t th b tt flies n this priced l t, M D l led thinks (and no man n E gland

an xcess in th numbe of th mal s. B t I am

and th arl m rge ce of th males w ll acco nt f his collectors securi lar r numbe f males than f f males, and conse q tly f th lower prices f the form W th respect t specimens reared from tl cat pillar tate, Dr Sta ding beli es, as pre ousl tated th t great r numbe f f males than f males di whil t confined to th cocoons. H adds th t with certain peci one sex seems to prepond rate o th th during certain ars.

Of direct bser ti ns n th sexes of Lepdopt ra, reared th from gg cat rp llars, I ha rece ed nly th f w f ll wi g case ...

So that n th se ht l t of cocoons and ggs, males w re prod ced n xcess. T n to th th proporti n f mal is as l t

Bla chard, *Met morphoses, Mœu de Insectes,* 1868, pp 225-26

Lepid pteren Do bletten Liste Berlin, No. 1866

See table page 390

INSECTS

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When this subject of the proportional numbers of the sexes of insects was brought before the Entomological Society [79] it was generally admitted that the males of most Lepidoptera, in the adult or imago state are caught in greater numbers than the females but this fact was attributed by various observers to the more retiring habits of the females and to the males emerging earlier from the cocoon This latter circumstance is well known to occur with most Lepidoptera as well as with other insects So that as M Personnat remarks the males of the domesticated *Bombyx yamamai* are useless at the beginning of the season and the females at the end from the want of mates.[80] I cannot however persuade myself that these causes suffice to explain the great excess of males in the above cases of certain butterflies which are extremely common in their native countries Mr Stainton who has paid very close attention during many years to the smaller moths informs me that when he collected them in the imago state he thought that the males were ten times as numerous as the females but that since he has reared them on a large scale from the caterpillar state he is convinced that the females are the more numerous Several entomologists concur in this view Mr Doubleday however and some others take an opposite view and are convinced that they have reared from the eggs and caterpillars a larger proportion of males than of females

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[75] *Th N t ral st n the Amazons* l t 1863 pp 228 347

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[77] Qu ted by Trim *T ns t ns f the Ent. Society* ol v part iv 1866 p 330

[74] *T t I* Soci ty l p 37 *I oc d g I tomologic l Society* 1 b 17 1868

[80] Qu ted by Dr W llace n *I oc d g Entomological Society* 3rd ser s, v l v 1867 p 487

ferent localities. B t as H Müller has himself remarked to me these remarks must be received with some caution, as n sex might more easily escape observation than the oth r Thus his brothe Fritz Müll has noticed n Brazil that th two se es of th sam pecies of bee sometimes freque t diff rent kinds of flo ers. With respect t the Orthopt ra, I know hardly anything about the relati e number of the sexes Kort [16] h w ve sa s that out of 500 locusts which h xamined, the males were t the f males as fi to six. With the Neuroptera, Mr Walsh states that in many b t b n m ans in all the species of the odonatous gro p, th re is great o erp us of males in the g nus H tærina, also, th males are generaly t least f ur times as num rous as the f males. In certain pecies in th genus Gomphus the males are eq all n e cess, whilst in tw oth species, the f males are t ice or thrice as m rous as th males. In some European speci of P socu thousand of females ma be collected w tho t a single male, whilst with oth peci s of the sam genus both se es are common.[19] In England, M MacLachlan has captured hundreds of the f male Apa ia mulubris but has ne er seen th male and of Boreus hyemalis only four or fi males ha e been seen h re [20] With most of these pecies (excepting th Tenthredinæ) there is at present no vidence that the females are ubject to partheno nesis and thus we see h w gnorant w are of th causes of the ppare t discrepancy in th pro-

which is som times carried to an xtreme degree) and thei wid ly diff re t appearance m account in some nstances f r thei rarity in collections.[22]

Som of the lower crustaceans are able to propag t their kind sexually and thi w ll account for th xtrem rari of the males thus v n S ebold caref lly examined no less than 13 000 specimens of Apus from twenty e local ties, and am st these he f und nly 319 males. With some other f rms (as Tana s and C pris) as Fritz Müll r nf rms me th is reason t belie e that th males are much shorte li ed than th f male and this would xplain their scarcity supposing th two se to be at first equal in number On the othe hand Müller has in ariably taken far m re males than f males of the D ast lidæ and of Cypridina n th shores of Brazil thus with a species n th latt genus, 63 specim ns caught th sam d included males but h suggests that this prepond rance m y be d e to som unkno n diff rence in the hab ts of th tw se es. With o of th hig' r Brazilian crabs, nam l a Gelasimus, Fritz Müller f und th males t be more n m rous than the females. According to the large expen nce of M C Spence Bat th re rse seems to be th ase with six common British crabs, the names of which h has gi en m

The proportion of the exes in r lat on to nat ral selection

Th re is reason to u pect th t in so cases man has by selectio indirectly in nced his own se producing pow rs. C rtain wom n t nd to prod ce d rin their whole li es more children of on sex than of th ther and th sam holds good of many animals, f n

nt horses, prod ced se n fillies. Tho gh I ha ery little vidence on this h ad, analogy would l ad t th belief that th t nd ncy to produce eithe sex w uld be inh rited lik almost e ery th peculiari for instance that of prod cing twins and concerning the abo tend ncy a good th nt M J Downing, has commun ated to me facts which seem to pro e that this does occu in certain families of short horn cattl Col.

[16] *Die Sprach, Z g oder Wanderheuschrecke*, 1828, p. 20.

[19] Observations N American Neuroptera, by H. H e and B D Walsh, *Proceed Ent. Soc. Philadelphia*, Oct., 1863, pp. 168, 223, 239.

[20] *Proceedings, Ent. Soc London*, Feb. 1 1868.

[21] Another great uthority th respect t this class, Prof Thorell of U psala (*O Eur pean Spiders*, 1869-70, part 1, p. 205), speaks as if female spiders were generally commoner than the males.

tended to this lass during many ears, writes to m that the males from th ir m re erratic ha its are more commonl seen, and therefore ppear more num rous. This is actually the case with f w pecies b t h m ntions se eral pecies in six genera, in which th females ppear t be much more numerous than the males.[22] The small size of th males in compariso with the f males (peculiarity

[22] ee, this subject, Mr O P Cambridg as quoted in *Quarterly J rnal of Science* 1868, page 429.

[23] *Beitrage zu Parthenogenesis*, p. 1 4

100 females But the numbers are hardly large enough to be trustworthy

On the whole from these various sources of evidence all pointing in the same direction I infer that with most pecies of Lepidoptera the mature males generally exceed the females in number whatever the proportions may be at their first emergence from the egg

It is hardly worth while saying anything about the proportion of the sexes in certain pecies and even groups of insects, for the males are unknown or very rare and the females are parthenogenetic that is fertile without sexual union examples of this are afforded by several of the Cynipidæ[83] In all the gall making Cynipida known to Mr Walsh the

	Male	Female
The Rev J H ll [84] of Exeter reared dur ng 1868 im gos of 73 speci s h ch co i t d of	153	137
Mr Alb rt J nes of Elth n reared durii g 1868 imagos of 9 pec es v l ich con sted f	159	126
Dur ng 1869 l reared magos f om 4 species co isti g f	114	112
Mr Buckler of I m rth Hants during 1869 reared in gos from 74 peci c ns sting of	180	169
Dr Wallace of C lchester reared from one brood f *Bombyx cynthia*	2	48
Dr Wall r sed fr m cocoons of *Bombyx pernyi* ent from Ch n during 1869	24	123
Dr W llace raised du i g 1868 ai l 1869 from two lots of coc ns of *B mbyx ya ian ai*	2	40
Total	934	61

With reference to the other Orders of insects I have been able to collect very little reliable information With the stag beetle (*Lucanus cervus*) the males appear to be much more numerous than the females but when as Cornelius remarked during 1867 an unusual number of these beetles appeared in one part of Germany the females appeared to exceed the males as six to one With one of the Elaterid the males are said to be much more numerous than the females and two or three are often found united with one female[85] so that here polyandry seems to prevail With Siagonium (Staphylinidæ) in which the males are furn hed with horns the females are far more numerou than the opposite sex Mr Janson stated at the Entomological Society that the females of the bark feeding *T micus villosus* are so common as to be a plague whilst the males are so rare as to be hardly known

females are four or five times as numerous as the male and so it is as he informs me with the gall making Cecidomyiidæ (Diptera) With some common pecies of saw flies (Tenthredinæ) Mr F Smith has reared hundreds of specimens from larvæ of all sizes, but has never reared a single male on the oth r hand Curtis says [86] that with certain p s (Athalia) bred by him the males were to the females as six to one whil t exactly the reverse occurred with the mature insects of the same species caught in the fields In the family of bees Hermann Müller collected a large number f specimens of many pecies and reared others from the cocoons and counted the sexes He found that the males of some peci s greatl exceeded the females in number in others the reverse occurred and in oth rs the two sex were nearly equal But as in most cases the males emerge f om the cocoons befor the females they are at the commencement of the breeding season practically in excess Müller also observed that the relative numbers f the two exes in some pecies differed much in dif

[85] Gunth r *Reco d of Zoolog al I t tur* 1867

[83] W lsh i the *Am ri Entomol g t* L i 1869 p 103 I S th *R d f Zoolog l Lit* 1867 p 328

[84] *I l ect* ii 45-46

[85] "An d g l D rwinsch n Lehre" *Verh. d. n. l J l a*

were estim te that I f l t i poss bl to ca late them

we ha un ~ —
males.

In cens s f all th ı la d ın 18 0[38] th males of all ages am unt to 36 2 2 and th f mal to 33 128 as 109 49 to 100 Th males und se tee y ars am unted to 10 3 and th f mal und the ame ag to 9 93 as 112.3 to 100 F m the census f 18 2 th proporti n f m l f all ge (cl ding half-castes) to f mal s, ıs as 125.36 t 100 It must b b rn n mind th t all th se t ns f tl Sand ch I land tl proport f l r m l to l g f mal s, and

ref rred t b rths[39]

[38]Th g ın th R H. T Cheever L f

the reclaimed nati es, w may uspect that, as th

breeds, th the cepti n, pe haps, of greyh ds, ma y more f mal p pp es re destroyed th males, just as th th Tod nf ts. M C pples

From tl e se eral f reg ıng cases we have som eason t b l e tl at nfant de p ac t ed th manne above explained tends to

pecı s, has been tl sol d t rmını g c an excess f m l s. Tl ere may be some un known l w l ad g to thı result decreasi g races, which l a e al eady becom somewh t ınf rtıle Be des the se ral causes p ı usly all ded t th g ter facıl ty of parturition am gst sa ages, and tl e l ss consequent ınj y t theı mal ınfants, wo ld te d to ıncrease th proport on of lı e-born mal s to females. Th re does not, l seem to be any necessary connecti n b t een savage l fe and marked cess f male tl at ıs ıf we m y judg by the haracter f tl e scanty ff

As the mal s and f mal s f many anımals d ff som wh t l bits and ar e posed ın diff rent d gree to dang r ıt s probable that n many cases, m re f n sex tl an f the oth r are hab tually destroyed B t as f as I

p od cı g pow f tl pecı s W th strı tly social animals, ch as bee r ants, which pro d ce a vast umb f st rıle and fert l fe mal compar son with the mal s, and to wl m thı prepo derance ıs f param t mpo tance w an see that th se commu tı w uld fl urısh b t wh h co taı ed fe mal h g a tro g ınh ted te d ncy to prod ce m re and m f m l s and ın ch cas an equal se prod g tend cy w ld be ultım t ly gaı ed th gh nat l select W th anım ls l g ın h rd troops, n which th mal come to tl fro t and d f d th h rd as w th th bison f N rth Ame ca and certain b boo s, t co ce bl th t m l prod g t d cy might b gained by n tu al select n f tl ınd d ls f tl b tt d f ded h d w ld l m m us d sc dants. In th case f mankı d th ad t g n g f m h g a prepo d ce f m ın th tr be p-

Marshall[94] has recently found on careful ex amination that the Todas a hill tribe of India, consist of 112 males and 84 females of all ages —that is in a ratio of 133 3 males to 100 fe males The Todas who are polyandrous in their marriages during former times invari ably practised female infanticide but this practice has now been discontinued for a con siderable period Of the children born within late years the males are more numerous than the females in the proportion of 1?4 to 100 Colonel Marshall accounts for this fact in the following ingenious manner Let us for the purpose of illustration take three families as representing an average of the entire tribe say that one mother gives birth to ix daughters and no sons a second mother has six sons only whilst the third mother has three sons and three daughters The first mother following the tribal custom destroys four daughters and preserves two The second retains her six sons The third kills two daughters and keeps one as also her three sons We have then from the three familie nine sons and three daughters with which to continue the breed But whilst the males belong to families in which the ten dency to produce sons is great, the females are of those of a converse inclination Thus the bias strengthens with each generation until as we find families grow to have habitually more sons than daughters

That this result would follow from the above form of infanticide seems almost certain that is if we assume that a sex producing tendency is inherited But as the above numbers are so extremely canty I have searched for addi tional evidence but cannot decide whether what I have found is trustworthy neverthe les the facts are perhaps worth giving The Maories of New Zealand have long practised infanticide and Mr Fenton states that he has met with instances of women who have destroyed four six and even seven children mostly females Howeve the universal testi mony of those best qualified to judge is con clu ive that this custom has for many years been almost extinct Probably the year 183? may be named as the period of its ceasing to exist Now amongst the New Zealander as with the Todas male births are considerably in excess Mr Fenton remarks (p 30) One fact is certain although the exact period of the commencement of this singular condition of the di proportion of the sexes cannot be demonstratively fixed it is quite clear that this course of decrease was in full operation during the years 1830 to 1844 when the non adult population of 1844 was being produced and has continued with great energy up to the present time The following statements are taken from Mr Fenton (p 6) but as the numbers are not large and as the census was not accurate uniform results cannot be ex pected It should be borne in min l in thi and the following cases that the normal state of every population is an exce s of women at least in all civilised countries chiefly owing to the greater mortality of the male sex during youth and partly to accidents of all kinds later in life In 18?8 the native populati n of New Zealand was estimated as con isting of 31 667 males an l ?4 303 females of all ages that is in the ratio of 130 3 males to 100 fe males But during this same year and in cer tain limited districts the numbers wer as certained with much care and the male of all ages were here 7 3 and the femaks 61(that is in the ratio of 1 males to 100 females. It is more important for us that during the same year of 18 8 the *non-adult* males ithin the same di trict were found to be 1 8 and the *non-adult* females 14? that is in the ratio of 1? 3 to 100 It may be added that in 1844 at which period female infanticide had only lately ceased the *non adult* males in one li tri t were ?81 and the *non-adult* females only 194 that is in the ratio of 144 8 males to 100 fe males

In the Sandwich Islan ls the males exceed the females in number Infanticide was for merly practised there to a frightful extent but was by no means confined to female infants, as is shown by Mr Ellis [96] and as I have been informed by Bishop Staley and the Rev Mr Coan Neverthel s another apparently tru t worthy v r ter Mr Jarves [97] whose ob erva tions apply to the l le archipelago remarks — Numb rs of v omen a e to be four l v lo confess to the mu l r of from three to ix or eigl t chil lr n and he adds femal s fr m being con l ed l s us ful than n ales v ere more often de troyed F om what is kr (n to occur in other parts of the world this state ment is probable but mu t l e receive l with n uch caution The practice of infanticide cea ed about the y ar 1819 wl en i lolatry as ab lished an l missi naries ettled in the is-

[94] *The Todas* 1873 pp 100 111 194 196
[95] *Aboriginal Inh b t t f New Z l nd* (Go rn me t Report) 1859 p 36
[96] *N rr t f T r th gh H wa* 1826 p 2?8.
[97] *H y f H ndwi h I l ds* 1843 p 93

CHAPTER IX

SECONDARY SEXUAL CHARACTERS IN THE LOWER CLASSES OF THE ANIMAL KINGDOM

WITH animals b lo gi g to th l we classes, the two sex s are n t ar ly nited n th sam indi d al, and th fo e ec da y xual characte can ot be de l ped In many cas h re th are separ t b th permanently tt ched t som s ppo t, an l ca t ea h truggl f th ther

be ty th tt act ns, to feel rival y H ce thes las es ub-ki gd ms, el

q ired thro l se l select wh cl d pends th ll, d and ho f th r sex. N th less som f w ppar t cep-

mal h ld th f m le, and wh ch ar d s-pensabl f th p p g t n f the peci ar d pe d t f se l lect n, and ha be acq ed througl d ry select

Many f tl l imals, wh th h maphrodites w th separ t se s, re rn m ted w th th m t brill t tints, are haded and tr ped an l gant m n f in tance many co ls and m (Ac tin æ) som j lly fish (Med sæ, I p ta, &) som Pl nar æ, many tar fi h Ecl ni as cid ans & b t may co l d f m the asons lready d cated, m ly th f th t se so f th anim ls, th perman tly ffi ed co dit n f th s, and the l w m ntal po f ll th t ch col urs d t rv as se l ttract and ha t bee q ed thr gh se al selec t It h ld b born m d th t in case h w uffici t d that col ur ha bee th acq ed cept wher se m ch more b lliantly co p ly col ur d than th ther and wh ther

d ff r nce n h b ts between the sexes suffi cient to cco t f tl d ffe e t col u But the e de ce is r d ed as complete as it ca er be ly l en th m re rn me ted d d ls, alm t l y tl m l s, ol n tar ly d play tl i ttr ct bef tl e th se f r w cann t bel e tl t l l-pl y seless, l f t l ad t ge s, e l s lecti n w ll almo t tably f ll W may howe r xt nd thi co cl on t both sexes, h n col ured al ke f tl i col rs a pl ly nal g us to tl se of ne se al n e tai th r pec s f tl e sa g up

H w th are we to account f tl e b auti

w ll b adm tted by ery e who ad Mr W llace cell t ssay o tl subject It ld t, f nst t fir t occu t ar y o th t th t an pa e f tl e Med æ, or j lly fi l f th h gl e t se ice to th m as a

appe ce ft n accompa ed by pri m t c col rs, w c n l rdly do bt th t th y tl s sc pe the t ce f pelag b rd and tl er en m es. M G ard also co ced th t the bright t t f certain po g and ascid ans se as protect n Co p cu colou s ar l k w se b fici l to many an mals as a w rn g to th w ld b d urers th t th y di tast f l th t th y po sess som pecial me s f d fence b t thi bject will b d s-ssed m con tly l aft

W an gn rance f m t of th l w t animals nly say th t th l right t t re lt tl e f m th chem cal n ture or th m n t tr tur f tl tis d p nd tly f any b n fit th d ed H rdly any col fi than th t of rt l blood b t th re is ason t pp th t the col f th blood tself any ad antag and th gh t add t th b ty f th n d n heek n n w ll prete d that t has be n acqui ed for

Arcl ves de Zoolog Expér Oct. 1872, p 563

posed to be one chief cause of the practice of female infanticide

In no case as far as we can see would an inherited tendency to produce both sexes in equal numbers or to produce one sex in excess be a direct advantage or disadvantage to certain individuals more than to others for instance an individual with a tendency to produce more males than females would not succeed better in the battle for life than an individual with an opposite tendency and therefore a tendency of this kind could not be gained through natural selection Nevertheles there are certain animals (for instance fishes and cirripedes) in which two or more males appear to be necessary for the fertilisation of the female and the males accordingly largely preponderate but it is by no means obvious how this male producing tendency could have been acquired I formerly thought that when a tendency to produce the two sexes in equal numbers was advantageous to the species it would follow from natural selection, but I now see that the whole problem is so intricate that it is safer to leave its solution for the future

pending on its mann r of growth. The amount of light seems t be influ ntial to a certain extent for altho h, as repe tedl stated b Mr Gwyn Jeffreys, th sh lls of some species living at prof und d pth are brightl col ured, t w g rally see th lowe surfaces, as w ll as th parts co red by th mantle, less highl -coloured than th uppe and x posed surfaces. In som cases, as w th shells livin amongst corals brightl ti ted se weeds, the bri ht colours ma serv as protectio B t tl t many of th n dibranch Mol
ure
All ... —
from inf rmati n kindl gi n m b M Hancock, t seems xtremely d ubtful wh th these colours usually serv as protect n. W th som pecies this ma be th case as with ne kind whi h lives th green lea es of algæ and is tself bright green. B t many brightl -colo red whit th rwise co spicu us pecies, d t seek concealm t hilst again som equall consp cu us species, a w ll as th dull-col red kind h und

ts general hab ts of life, the more brightl tinted indi d ls w uld s cceed best and w uld ncrease in number but this w ld be a case of nat ral and not of sexual select n.

Sub-ki gdom of the VERMES. Class AN NELIDA (or Sea w rms) —*In this class*, al though the sexes, wh n separate sometimes *diff from ach oth in characters f ch* importance that th y h been placed und distinct g era o n famil es, yet th diff r ence do n t seem of th kind whi h can be safely attributed to sexual selecti n. These animals are often be utifully coloured b t as th se e d n t diff in this respect, we are but littl co cerned with th m. E n th ne m rtians, though so lowly organised, m be ty and ari ty of colouring with any ther gro p in th in rt brat seri " yet D McIntosh cann t discov that these colours are of an service The sed ntary ann lids be com dulle -coloured, according to M Quatrefages, *after th period f reproduction* and this I presume may be ttributed to th ir less vi orous conditi n at that tim All these w rm lik animals pparently tand too low in the scal f r the indi duals of either sex t rt any cho ce in selecting a partne o f the indi iduals of the same sex to struggle together in ri alry

S b-k gdom of the ARTHROPODA Class CRU T CEA.—In this gre t lass we first meet with undo bted secondary sexual charact rs, oft n d loped in a remarkable mann r. U f rtunat ly th hab ts of crustaceans are ry imperfectl kn wn, and w cannot xplain tl uses of man tru t res pec liar t on sex. W th th l w parasitic speci the males are of small size and th alo are furnished with perfect swimming legs, ant nnæ and sense-organs th f males being destit t of these organs, with th ir bodies ft n consisting of a mere distorted mass. B t these xtraordinary diff re ces between th tw sexes are no d ubt related to th ir wid ly diff rent hab ts of life, and consequ ntl d n t co cern us. In ari us crustaceans, belo ging t distin t famil s, the *ant n* ant nnæ are furnished with peculiar thread lik bodies, which are bel ed t act as sm lling-o gans, and these are much m re num rous in the males than in the f mal s. As

their pare ts gre t be ty B t with such lowl -organised cre tures this xtrem ly improbabl N is t t all obvi us h w th off pring from th more be tiful pairs of herm phrodit would ha an ad antag th off pring of th less be tif l, so as to increase in umbe unless indeed vi our and bea t g nerall coincided W h not h re the case of n mbe f males becoming mature bef re the f males, with th more bea tiful males selected b th m re vigorous females. If indeed, brilliant colours w re be eficial to h rmaphrod t animal in relati n to

I have give (*Geological Observations on Volcanic Islands* 1844 p. 53) curious instance of the nfluence of ligh the colours of fro desce t ncrustatio deposi ed b the surf the coast rocks of Ascensio nd f rmed by the solutio of triturated sea-shells.

D M rse has lat ly discussed th subject in his paper be Adap Coloration of Mollusca, *Proc Boston Soc of Nat. Hist.*, ol. xi April, 1871

See his beautiful m graph *British A nelids*, part i., 1873, p. 3.

See M. Perrier L Origine d l Homme d pres Darwin, *Revue Scientifique* Feb 1873, p. 866.

this purpose So *again* with many animals e pecially the lower ones the bile is richly col oured thus as I am informed by Mr Hancock the extreme beauty of the Eolidæ (naked sea slugs) is chiefly due to the biliary *glands* being seen through the translucent integuments—this beauty being probably of no service to these animals The tints of the decaying leaves in an American forest are described by every one as gorgeous yet no one supposes that these tints are of the least advantage to the trees *Bearing in mind how many substances closely* analogous to natural organic compounds have been recently formed by chemists and which exhibit the most plendid colours it would have been a strange fact if substances simi larly coloured had not often originated in dependently of any useful end thus gained in *the complex laboratory of living organisms*

The sub l ingdom cf the MOLLUSCA Through out this great division of the animal kingdom as far as I can discover secondary sexual char acters such as we are here considering never occur Nor could they be expected in the three *lowest classes namely in the ascidians I oly* zoa and brachiopods (constituting the Mol luscoida of some authors) for most of these animals are permanently affixed to a support or have their sexes united in the same in h vidual In the Lamellibranchiata or bivalve shells hermaphroditism is not rare In the *next higher classes of the Gasteropoda or uni* valve shells the sexes are either united or separate But in the latter case the males never possess *special organs for finding securing or* charming the females or for fighting with other males As I am informed by Mr G vyn Jeffreys the sole external difference between the sexes consists in the shell sometimes differ ing a little in form for instance the shell of the male periwinkle (*Littorina littorea*) is nar *rower and has a more elongated spire* than that of the female But differences of this nature it may be presumed are directly connected with *the act of reproduction or with the develop*ment of the ova

The Gasteropoda though capable of loco-motion and *furnished v ith imperfect eyes do* not appear to be endov ed with sufficient men tal po vers for the members of the ame sex to struggle together in rivalry *and thus to ac quire* secon lary sexual characters Ne ertl e less with the pulmoniferous gasteropods, or land snails the pairing is preceded by court ship *for* these animals, though hermaphro-dites are compelled by their structure to pair together Agassiz remarks, *Quiconque a eu l occasion d observer les amours des limaçons ne saurait mettre en doute la séduction déployée dans les mouvements et les allures qui préparent et accomplissent le double embrassement de ces hermaphrodites* [1] These animals appear also susceptible of some degree of permanent at tachment an accurate observer Mr Lons-dale informs me that he placed a pair of land snails (*I*

weakly

After a s

dividual disappeared and vas traced l y its track of slime over a v all into an adjoining *well stocked garden* Mr *Lonsdale concluded* that it had de erte l its sickly mate but after an absence of twenty four hours it returned, and apparently communicated the result of its successful exploration for both then started along the same track and disappeared over the wall

F n in tl e l ighe t class of the Mollusca,

1 11 ide el ped

from an enemy [2] Certain Cephalopoda *low ever are cha acterise l by one extraordinary* sexual character namely that the male ele ment collects witl in one of the arms or ten *tacles which is tl en cast off and clinging by* its sucking lises to tl e female lives for a time an in lependent life So completely does the cast off arm resembl le a s parate *animal* tl at it v as described by Cuvier as a parasitic w rm under the name of Hectocotyle But this marvellous structure may be classed *as a* primary rather than as a secondary sexual character

Although v ith the Mollusca sexual selection *does not seem to ha e come into play yet* many univalve an l bivalve shells, su l as volute

colour

pear n

ti n they are probably tl e direct result, as in *the lowest classes of the n ture of tl e tissues* the patterns and the sculpture of tl e sl ell de-

[1] *De l*

[2] See

n my

equalit in th f male on the opposite sides of th bod In G lasimus, according to a statement quoted by Milne Edwards, the male and the female liv in th sam burrow and this shew that they pai the mal loses th mouth of the burrow with one of its ch læ which is enorm usl de eloped so that h re it

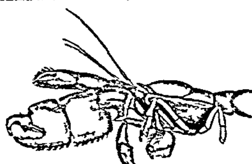


Fig. 5 Anterior part of body of Callianassa (from Milne Edwards), showing the unequal nd diff re tly-constructed right nd left hand helæ of the male

N B The artist by mistak has re ersed th drawing and made the left hand chela th largest.



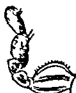


Fig. 6 Fi 7

F g. 6 Second leg of male *Orchestia tucurati ga* (from Fritz Muller).

F g. 7 D tt of female.

indirectl serves as m ans of d fence Th ir main se howe is probabl to seize and t secure the f male and thus in som instances, as th Gammarus, is kn wn to be th case Th male of th h rmit or soldie crab (Pagurus) for weeks togethe carries bo t th sh ll nhab ted b th f mal [15] Th sexes, how of th common shore-crab (Carcinus manas) as M Bat informs m unit directly after th f male has m ulted her hard sh ll, whe sh *is so soft that she w uld* be injured if seized b th trong p ncers of the mal b t as sh is caught and carried about by the male before moulting, she could then be seized with impun ty

Fritz Müller states that certain species f M lita are distinguished from all oth amphi pods by the f males ha ing the coxal lam llæ f th pe ultimate pair of feet produced into hook like processes, of which the males lay hold with the hands of th first pair The d lopm nt f these hook like processes has probably followed from those f males which were th most securely held during the act of reproduc ti n, having l ft th largest numbe of off pring An *ther Brazilian amphipod* (*Orchestia darwi i*, fig 8) presents a case of dim rphism, like th t of Tanais f r th re are tw mal f rms, which differ in th tru t re of their chelæ [16] A eithe h l w ll cert ly suffice to hold the f mann r and som in anothe both forms ha ng d ri ed certain special, b t nearly equal ad antages, from their diff re tly sh ped rgans.

It is n t known that male crustaceans fight to the f the possession of the f males, but t is probably the case for with most animals wh n th mal is larg r than th f male, h seems to we his gre te size to his ancestors ha ing fo ght with other males during man gen rati ns. In most of the ord rs, especially in th highest or th Brach ura, the mal is larg than th f mal th parasiti gen ra, h w in which th sexes f llow diff re t hab ts of life, and most of th Entomostraca must be excepted. Th ch læ of many crustaceans are we pons w ll ad pted f fighting. Thus when a devil crab (*Port us p ber*) was seen by a son of M Bat fighting with *Carci us manas* th latt was soo thrown n its back, and had ry limb torn from ts body Wh n se ral males of a Brazilian G lasimus, speci fur nished with imm nse pincers, w re placed tog th n a glass essel b Fritz Müll r th y mutilated and killed an th Mr B t p t a larg male *Carci us manas* to a pan f w t nhab ted by f mal which was paired with a small mal b t th latt was

[14] *Hist Nat de Crust.*, tom. ii., 1837 p. 50.

[15] Mr C pence Ba *British Association, Fourth Report on the F una of S. Devon.*

[16] Fritz Muller *Facts and Arguments for Darwin*, 1869 pp. 25-28.

the males without any unusual development of their olfactory organs would almost certainly be able sooner or later to find the females the increased number of the smelling threads has probably been acquired through sexual selection by the better provided males having been the more successful in finding partners and in producing offspring Fritz Müller has described a remarkable dimorphic species of Tanais in which the male is represented by two distinct forms which never graduate into each other In the one form the male is furnished with more numerous smelling threads and in the other form with more powerful and more elongated chelæ or pincers which serve to hold the female Fritz Müller suggests that these [illegible] ween the [illegible] nay have [illegible] ng varied [illegible] mber of the smelling threads whilst other individuals varied in the shape and size of their chelæ [illegible]

[illegible] t the greatest number of progeny to inherit their respective advantages [3]

In some of the lower crustaceans the right anterior antenna of th [illegible]

[illegible] as I hear from Sir J Lubbock to hold the female and for this same purpose one of the two posterior legs (b) on the same side of the body is converted into a forceps In another family the inferior or posterior antennæ are curiously zigzagged in the males alone

In the higher crustaceans the anterior legs are developed into chelæ or pincers and these are generally larger in the male than in the female —so much so that the market value of the male edible crab (*Cancer pagurus*) according to Mr C Spence Bate is five times as great as that of the female. In many species the chelæ are of unequal size on the opposite side of the body the right hand one being, as I am informed by Mr Bate generally though not invariably the largest. This inequality is also often much greater in the male than in the female The two chelæ of the male often differ

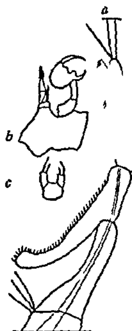


FIG 4 *Lab dor d* [illegible] (from Lubbock). a P rt f r ght nt r r nt n a f m le, f rming a preh l o g n b l len r p ir f thor c leg of m l c D tt of female

in structure (figs [illegible] 6 and 7) the smaller one resembling that of the female What advantage is gained by the [illegible]

[illegible] way when they are of equal size both are often much lar[illegible]

[illegible] at they cannot possibly be used for carrying food to the mouth In the males of certain fresh water prawns (Palæmon) the right leg is actually longer than the whole body [1] The great size of the one leg with its chelæ may aid the male in fighting with his rivals but this will not account for their un[illegible]

Facts and Arg m nt for D [illegible] English tran lat. 1869 p 20 S th p [illegible] n on th [illegible] a some [illegible] 870 p 455) n [illegible] 1853 pls. [illegible] d x. nd [illegible] (1853) pl. vi See also Lubbock in *T nsactions E tomological Society* v [illegible] iv new series, 1856-1858 p 8 With respect t th gzagged nte nn nt ned below see Fritz Müll r *Fact nd A g ments for Darwin*, 1869 p 40 footn t

[1] See a pape by Mr C Spe ce B t th figures n *Proc d g Zoolog al Society* 1868 p 363 [illegible] tl n lature f th g us, *ibid* p 85 I m greatly d bted t M p ce B t [illegible] arly ll th bo e tat n ts w th respect t th ch læ of th h gh crustace ns.

In this case we ma suspect th agency of sexual selection. From M. Bert observati ns
a d a essel illumi

are abse t in the f males, and in both sexes of one species.[18] It w uld, howeve be extremely rash t conclud that these curi us organs serv t attract the f males. I am inf rmed by F tz Muller that in th f mal of a Brazilian species of G lasimus, the whole bod is of a nearl uni rm gre ish-brown. In th mal th posterior part of th cephalo-thorax is pure whit with th ant rior part f rich green, shading into dark brown and t is remarkable that these colours are liabl to change in th course of few min tes—th whit becoming dirt gre or n black, th green losing much of ts brilliancy It deserves especial notice that th males d not acquire th ir bright colours until th becom mature Th y ppear to be m ch m re um rous than th f males they differ also in th large size of their ch lae. In som peci of th g us, probabl in all, the se es pair and inhab t th sam burrow Th are also, as w ha seen, highly intelli t animals. From these ari us consid erations t seems probable that th male in this species has become gail rnam nted in rd to attract ect th female

It has ju t bee tated that the male G lasi mus does ot acq ire his conspicuous colours until mature and nearl read t breed This seems general rul in th wh le lass re spect to th man remarkable structural diff ences betwee the se es. W shall h reaft find the sam law pre ailing through ut th great sub-king m of th V rt brata and in al ases t is mu ll distincti of char acters which ha bee acq ired through sex ual selection. Fritz Muller gi es som trikin instances of th law thus th male sand hoppe (Orchestia does ot until nearly full grown, acquire his large cla pers, which are ry dif f re tl constructed from those of the f male whilst g his la pers resemble those of th f male

Class Arachnida (pid rs) —Th se es do not gen rally diff r much n colour but the males are ft n dark r than th females, as may be seen in Mr Blackwall s magnificent work. In som species, h w er the d ff r nce is con p cu u th the female of Sparassus smaragdulus is dullish green, whilst th adult mal has the abd men of a fin y ll w with three longitudinal stripes of rich red In certain species f Thomisus the sexes closely resembl ach th in th rs th y diff mucl and analogous cases occur in many oth r genera. It is often difficult to say which of th two se es departs most from the ordinary colorati n of th g nus t which th pecies belo b t M Blackwall thinks that as a g neral rule, t is the male and Canestrini remarks that n certain genera th males n be pecifically distinguished with ease, b t th f m les with great difficult I am informed b M

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cessi m ults, bef re arri in t maturity In oth r cases th mal alo ppears to chang colour Thus th male of the abo bright coloured parassus t first resembles th f mal and acquires his peculiar tints only when n arl ad lt. Spid rs are possessed of acute senses, and xhib t much intelli nce as s w ll known, th females often sh w th strongest affecti f th ir gs, which th y carry abo t n loped a silk n web Th males search a l f th f males, and ha been seen b Canestrini and thers to fight f posses n f th m This sam thor say that th uni n f th two sexes has been observed in abo t tw ty species and h asserts positi l th t th femal rejects som of the males who court her threat ns th m w th pen mandibles, and t last aft lo g hes tati accepts th chosen

From these se ral considerati ns, w ma admit with som confid nce that the w ll marked diff rences in colo betw en th se s certain species are th res lts of sexual selec ti though w ha not h re th best kind of evid nce —th display b th male of hi ornam nts. From th trem anabl t f colo in th male f som species, f n tance of Theridio l nea, m t w uld ppear that

I am debted t Mr Bat for D P er statement

[18] laus, Die f rtpflanzen C pepoden, 1863, s. 35. Facts nd A guments, &c p. 9.

Arachnids in the Atti della Soc. Veneto-Trentina d Sc. Nat Padova, ol. fasc. 3, 1873

soon dispossessed Mr Bate adds if they fought the victory was a bloodless one for I saw no wounds This same naturalist separated a male sand skipper (so common on our sea shores) *Gammarus marinus* from its female both of whom were imprisoned in the same vessel with many individuals of the same species The female when thus divorced soon joined the others After a time the male was put again into the same vessel and he then after swimming about for a time dashed into the crowd and without any fighting at once took away his wife This fact shews that in the Amphipoda an order low in the scale the males and females recognise each other and are mutually attached

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tries to catch one of the shore crabs so common on tropical coasts will perceive how wary and alert they are. There is a large crab (*Birgus latro*) found on coral islands which makes a thick bed of the picked fibres of the cocoa nut at the bottom of a deep burrow It feeds on the fallen fruit of this tree by tearing off the husk fibre by fibre and it always begins at that end where the three eye like depressions are situated It then breaks through one of these eyes by hammering with its heavy front pincers and turning round extracts the albuminous core with its narrow posterior

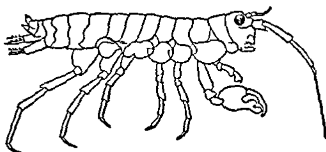
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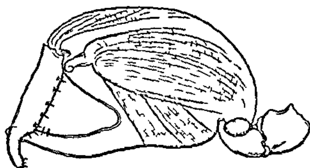
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mal as by an old one The following case however can hardly be so considered a trustworthy naturalist Mr Gardner [1] whilst watching a shore crab (Gelasimus) making its burrow threw some shell towards the hole One rolled in and three other shells remained within a few inches of the mouth In about five minutes the crab brought out the shell which had fallen in and carried it away to a distance of a foot it then saw the three other shells lying near and evidently thinking that they might likewise roll in carried them to the spot where it had laid the first It would I think be diffi-

cult to distinguish this act from one performed by man by the aid of reason

Mr Bate does not know of any well marked case of difference of colour in the two sexes of our British crustaceans in which respect the sexes of the higher animals so often differ In some cases however the males and females differ slightly in tint, but Mr Bate thinks not more than may be accounted for by their dif-





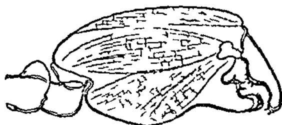


Fig 8 O h t a l n (Fr Frt M(ll) h g the differently-c n tructed ch lae f th t m l f rms.

ferent habits of life such as by the male wandering more about and being thus more exposed to the light Dr Power tried to distinguish by colour the sexes of the several species which inhabit Mauritius but failed except with one species of Squilla probably S stylifera the male of which is described as being of a beautiful bluish green with some of the appendages cherry red whilst the female is clouded with brown and grey with the red about her much less vivid than in the male

[1] T t ls th Int rior f B ~l 1846 p 111 I have gi e in my J I f R rch p 463 an account of th h b t f the B rgus.

[2] Mr Ch. Fraser n P oc Zoolog Soc 1869 p 3

CHAPTER X

SECONDARY SEXUAL CHARACTERS OF INSECTS

In the immense class of insects the sexes sometimes differ in their locomotive-organs, and often in their sense-organs, as in the pectinated and beautifully plumose antennæ of the males of many species. In Chloeon, one of the Ephemeræ, the male has great pillared eyes, of which the female is entirely destitute. The ocelli are absent in the females of certain insects, as in the Mutilidæ, and here the females are likewise wingless. But we are chiefly concerned with structures by which one male is enabled to conquer another, either in battle or courtship, through his strength, pugnacity, ornaments, or music. The innumerable contrivances, therefore, by which the male is able to seize the female may be briefly passed over. Besides the complex structures at the apex of t

for the seemingly insignificant object of enabling the male to grasp the female firmly. The mandibles or jaws are sometimes used for this purpose; thus the male Corydalis cornutus (a neuropterous insect in some degree allied to the dragon flies, &c.) has immense curved jaws, many times longer than those of the female; and they are smooth instead of being toothed, so that he is thus enabled to seize her without injury. One of the stag-beetles of North America (Lucanus elaphus) uses his jaws, which are much larger than those of the female, for the same purpose, but probably likewise for fighting. In one of the sand-wasps (Ammophila) the jaws in the two sexes are closely alike, but are used for widely different purposes; the males, as Professor Westwood observes, "are exceedingly ardent, seizing their partners round the neck with their sickle-shaped jaws"; whilst the females use these





FIG. 9. Crabro cribrarius. Upper figure male; lower figure female.

organs for burrowing in sand-banks and making their nests.

The tarsi of the front legs are dilated in many male beetles, or are furnished with broad cushions of hairs; and in many genera of water-beetles they are armed with a round flat sucker, so that the male may adhere to the slippery body of the female. It is a much more unusual circumstance that the females of some water-beetles (Dytiscus) have their elytra deeply grooved, and in ... thickl

Sir J. Lubbock, Transact. Linnean Soc., vol. xx 1866, p. 484. With respect to the Mutilidæ see Westwood, Modern Class. of Insects, vol. ii. p. 213.

These organs in the male often differ in closely allied species, and afford excellent specific characters. But their importance from a functional point of view, as Mr. R. MacLachlan has remarked to me, has probably been overrated. It has been suggested, that slight differences in these organs would suffice to prevent the intercrossing of well-marked varieties or incipient species, and would thus aid in their development. That this can hardly be the case we may infer from the many recorded cases (see, for instance, Bronn, Geschichte der Natur, B. ii., 1843, s. 164; and Westwood, Transact. Ent. Soc., vol. iii., 1842, p. 195) of distinct species having been observed in union. Mr. MacLachlan informs me (vide Stett. Ent. Zeit., 1867, s. 155) that when several species of Phryganidæ, which present strongly-pronounced differences of this kind, were confined together by Dr. Aug. Meyer, they coupled, and one pair produced fertile ova.

The Practical Entomologist, Philadelphia, vol. ii., May 1867, p. 88.

Mr. Walsh, ibid., p. 107.

Modern Class. of Insects, vol. ii., 1840, pp. 205, 206. Mr. Walsh, who called my attention to the double use of the jaws, says that he has repeatedly observed this fact.

these sexual characters of the males have not as yet become well fixed Canestrini draws the same conclusion from the fact that the males of certain species present two forms differing from each other in the size and length of their jaws and thus reminds us of the above cases of dimorphic crustaceans

The male is generally much smaller than the female sometimes to an extraordinary degree [0] and he is forced to be extremely cautious in making his advances as the female often carries her coyness to a dangerous pitch De Geer saw a male that in the midst of his preparatory caresses was seized by the object of his attentions enveloped by her in a web and then devoured a sight which as he adds filled him with horror and indignation [1] The Rev O P Cambridge[22] accounts in the following man

...

tive male escapes from the ferocity of the female by gliding about and playing hide and seek over her body and along her gigantic limbs in such a pursuit it is evident that the chances of escape would be in favour of the ... whilst the larger ones would

...

crative functions —in fact probably to the size we now see them i e so small as to be a sort of parasite upon the female and either beneath her notice or too agile and too small for her to catch without great difficulty

Westring has made the interesting discovery that the males of several species of *Theridion*[23] have the power of making a stridulating sound, whilst the females are mute The apparatus consists of a serrated ridge at the base of the abdomen against which the hard hinder part of the thorax is rubbed and of this structure

...

mopter a to be described in the next chapter we may feel almost sure that the stridulation serves as Westring also believes, to call or to excite the female and this is the first case known to me in the ascending scale of the animal kingdom of sounds emitted for this purpose [24]

Class MYRIAPODA —In neither of the two orders in this class the millipedes and centipedes can I find any well marked instances of such sexual differences as more particularly concern us In *Glomeris limbata* however and

...

In some species of Iulus the tarsi of the male are furnished with membraneous suckers for the same purpose As we shall see when we treat

extremity ... er ...

[20] Kirby ... d Spe ... *Introd to Entomology* ... 1818 p 280

[22] *Proceedings Zoolog Society* 1871 p 621

[23] ...D ... H ... n Z ... coll ... several

[24] Westring ... G ... *H* ... 1847 p 17 19 68

tat all the Lampyridæ wh ch he has tried are highl, unsast ful t insecti orous mammals and birds. H nce t s in accordance w th M Bates view hereaft to be plained that many insects mimic the Lamp ridæ losel in order to be mistak n for th m, and thus to escape estruction. He furth bel es that the luminous species profit b being t nce recognised as unpalatable. It is probable that the same planation m be ext nded to the aters, both se es of which are highl lum nous. It is not known wh th win of the female glow worm h ve not been d relo ped b t in h prese t stat su closel resembles larva, and as larvæ are so largel preyed n

smaller than the f males and this diff rence can often be d ected n in th larval tate So considerable is th dif rence between the male and f male cocoon of the silk moth (Bom yx mori) that in France th are separated b particular mo of w ighing.[1] In the lower classes of th animal kingdom, the great si of the females seems generally to depend on their k pin an enormous number of a and this ma t certain tent hold good th insects. b t D Wallace has suggested much more probable planation. H finds, after carefull tt nding t the d lopme t of th cat rpillars of Bomby cynthia and yamam and especially t th t of some dwarfed cat rpillars reared from second brood on unnat ral food th t in pr portion as the indi idual moth is finer so is the time required for ts metamorphosis lo ge and for this reason th f male which is the large and hea ier insect, from ha ing t carry he nu merous eggs, will be preceded b the male hich is smale and has less to mat re N w as most insects are short-li ed, and as th are posed t man dan ers, t would manifestl be ad antageous t the female t be impregnated as soon as possible This nd would be gained b the males being first mat red large numbers read for th ad ent of th f males and this again ld nat ral follow as M A. R. Wallace has remarked,[2] through natural selection for the smalle males would be first

matured and thu would procreate a large number of off pri which would inherit the reduced si f th r male parents, whil t the large mal fr m being matured lat r would l e few off prin

Th re are h w er e ceptions to th rule ot be smaller than the f males

f males and n these cases, as with the tag beetle (Lucanu) the males are larger than the f males. There are how er other beetles which are n t known to fight to geth of which th males xceed th e f males in size and the m aning of this fact is not known but in some of these cases, as w th the huge Dyna tes and M asoma, we can t least see that th re would be no necessit for the males to be smalle than th f males, in ord to be ma t red bef re th m f these beetles are n t

and as M MacLa hlan beli es, th d not nerall pai w th th f males until a week or fortnight has lapsed, and until th ha e assumed their pr pe masculine colours. B t the mo t curious case su wing on what com ple and asil o looked rel ti ns, so trifling haract as dif rence in siz between th se es ma d pend is that of the acul t H m n ptera f M F Smith informs m that through ut nearly the whole of this large gro p, th males, accordance w th the g neral rule re smalle than the f males, and m rge abo t a week bef re th m but amongst the bees, the males of A is m cea, A m m ca m and A thophora acervorum and amon t th fossores, th males of th Methoca are larger than th females. The explanation of this anom aly that a marriage flig t is absol t ly ecessary w th these pec es, and th male requires gre t trength and siz in ord to carry th f male throu th air Increased size has h re been acquired in pposition to th usual relati n between siz and th period of d elopment for th males, though larger merge before th smalle f males.

W will now revi w th se eral Ord rs, selectin such facts as more particularl con

[1] Robinet Ver Soie 1848, p. 207
[2] Transact. Ent. Soc. 3rd series, ol. p. 486. Journal of Proc Ent. Soc. 4 h 4, 1867 p. lxxi.

For th nd other st t me ts on the size of the se es, see Kirb nd pe ce Ent., ol. iii, p. 300 on the duratio of lif in insects, see p. 344.

set with hairs as an aid to the male The females of some other water beetles (Hydroporus) have their elytra punctured for the same purpose [6] In the male of *Crabrocribrarius* (fig 9) it is the tibia which is dilated into a broad horny plate with minute membraneous dots giving to it a singular appearance like that of a riddle [7] In the male of Penthe (a genus of beetles) a few of the middle joints of the anten

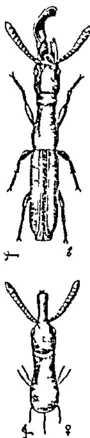


Fig 10 *Tafl od l t t* (mu l c l rg ed) Upper figure n ale l figur fen l

næ are dilated and furnished on the inferior surface with cushions of hair exactly like those on the tarsi of the Carabi læ, and obviously for the same end In male dragon flies the appendages at the tip of the tail are modified in an almost infinite variety of curious patterns to enable them to embrace the neck of the female Lastly in the males of many insects, the legs are furnished with peculiar pines, knobs or spurs or the whole leg is bowed or thickened but this is by no means invariably a sexual character or one pair or all three pairs are elongated sometimes to an extravagant length [8]

The sexes of many pecies in all the orders present differences of which the meaning is not understood One curious case is that f a beetle (fig 10) the male of which has left mandible much enlarged so that the mouth is greatly distorted In another carabidous beetle Lurygnathus [9] we have the ca e unique as far as known to Mr Wollaston of the l ead of the female being much broader and larger though in a variable degree than that of the male Any number of such cases could be given They abound in the Lepidoptera one of the most extraordinary is that certain male butterflies have their fore legs more or less atrophied with the tibiæ and tarsi reduced to *mere rudimentary knobs The wings, also, in* the two sexes often differ in neuration [10] and sometimes con iderably in outline as in the *Iricoris cpitus* which was shewn to me in the *Briti h Museum by Mr A Butler* The males of certain South American butterflies have tufts of hair on the margin of the wings and horny excrescences on the discs of tl e po terior *pair* [1] *In several British butt rflie* as shewn by Mr Wonfor the males alone are in parts clothed with peculiar scales

The use of the bright light of the *female glow worm has been ubj ct to much liscus*sion The male is feebly luminou as ar tl e larva and even the egg It l as been supposed by some authors tl at tl e ligl t serves to *frighten away enemies and by others to guide* tl e male to the f male At last, Mr Belt[11] appears to have solved the difficulty l e finds

See Dr H Schaum s q ted tl *Zool g t* v ls 1847-48 p 1896 Also K by n l Spence *Int od ction to Ent mology* vol 1826 p 30

[7] W twood *M dern Cl* v l p 193 Th f ll g st t m nt bout l ith l th rs in i rt l commas, are tak n from Mr W bl *I actical E domologist,* I h lad lph a, l u p. 68.

K by and Spence *Introd ct. &c* vol i pp 332 336

Ins ta Mad nna 1854 p g 20

E. D bled y *l Is nd M g of Nat Hist.* vol 1848 p 3 0 I m y add that the ng n cert n Hym pt ra (see Sl uckard *F sorial Hy pt* 1837 pp 39-43) d ff r i n r t c cord g to se

H W B t s, *Jo l f l oc I Soc* vol

that this is se al charact r e ceptu g th t th no social insects the seem to b n se f r sound prod ci g gans unless it be as se al call.

astonished ... ...

The f males re m te as the Grecian poet Xenarch says Happy the cicadas l e since th y all ha e ecl ss w s Th n se thus made co ld b pl nly l ard board the *Beagle* h n anch ed t q rt f a mile from th h e f B azil and Captain Hancock says it ca be h ard t th distance f mile The Gre ks f rm ly k pt and the Cl ese n w keep tl se insect g s f r tl e

b an set to act by spec l m scl In th l g sect, h lst t id lat g th m m b an can be sec to b t d th d ad asect tl proper sound h rd f th m scl h l ttl d d nd hard ed pulled with th po t f p In th f mal th wh l complex mus cal pp t p sent b t is m h less d loped than th mal d s t l f p od ing sound

W th pect t th bject f th mus D Hartman peaking f tl *Cic d ptem decim* f th U ted States, says,[26] Th d ms are (J 6th d tf 1851) heard ll directio Th I b l t b th mart al mm ns f m th mal Stand g n th k l t t pro t abo t as h gl as my l ad l re h nd ed re und m I bse ed tl f males com ng round th d mm g mal H lds, Tl seaso (A g 1868) a d rf pear tree my g rden j rod ed bo t

fifty l r æ of *C pru osa* and I several tim s noti ed the femal s to l gl t near male wh le he was ttering l is langu g note Frit Mül l t s to me f m S Brazil that h l as ft n

l ma s,

o ly find th m by the r so nds, but that l ke f mal b rds they are cited r all ed by the mal tl th m t attract e vo ce

I l ve n t h rd of a y well marked ases f rnament l d ff ren es b tween the se of tl e H m ptera Mr D uglas f m me tl t tl e e three Britisl pecies, i wl ich tl e mal bl ck or m ked w th black b ds wl lst th f mal re p le-col ed r bsc re

Ord O TH PTERA (C kets and Grass-l pers) —The males in the three saltat rial

eq le t Engl h m and the A rid dæ o gras h pp Th trid lat n prod ced by some f the Locu tidæ is so l d that it can be h ard d ri g tl gl t t the distance f m l [22] and that mad by ce tain pec es is n t unm l n to the l man ar so that th Ind ans th Amazo keep tl m in wicke cages All bsers rs gree tl t the sou d rı itl t call ite tl mute f males. W th pect to th mig atory locu ts f R s-ia, K rt has gi n[28] n u t ting case f select by th f m l f mal The m l f tl peci (*Pach ylus m g at*) whil t upled th th f mal t d l t from ang j l y if pp ached by th r males Tl l use-cri k t he urprised t n ght use ts ce t warn t f ll w [29] In N rth Am ri th Katy d d (*Platyphyll m c ca m f th Locustidæ*) is described[30] as mo t g n the uppe b h f tree and n th ning beginn g hi y babble wh l ri al n t iss from tl n ghbo ring tr and tl gr so d th th ll f *Katy-did*

[25] These p rticulars are tak from W t ood *Moder Cl f ion f I sects* l. 1840 p 422. See lso tl Fulg dæ, Kirby d pe ce *Int oduct* l. p 401

[26] *Zeitschrift f ssensch ft Zoolog* B xvii. 1867 152 158

[27] *T nsact ns of the New Zealand Institute,* l. 18 3 p 286

[28] I m debted t M W Lh for his g se t in this ract from *A J rnal f the Doi g Cic d pt idec m*, by D Hartm n.

[29] L. Guildi g *T nsact f tl L nne Society* l 154

... 1825 p 262.

H rr s, *Insect f N Engl nd*, 1842, p 128

cern us The Lepidoptera (butterflies and moths) will be retained for a separate chapter

Order THYSANURA —The members of this lowly organised order are wingless dull coloured minute insects with ugly almost misshapen heads and bodies Their sexes do not differ but they are interesting as shewing us that the males pay sedulous court to the females even low down in the animal scale Sir J Lubbock[17] says It is very amusing to see these little creatures (*Smynthurus luteus*) coquetting together The male which is much smaller than the female runs round her and they butt one another standing face to face and moving backward and forward like two playful lambs Then the female pretends to run away and the male runs after her with a queer appearance of anger gets in front and stands facing her again then she turns coyly round but he quicker and more active scuttles round too and seems to whip her with his antennæ then for a bit they stand face to face play with their antennæ, and seem to be all in all to one another

Order DIPTERA (Flies) —The sexes differ little in colour The greatest difference known to Mr F Walker is in the genus Bibio in which the males are blackish or quite black and the females obscure brownish-orange The genus Elaphomyia discovered by Mr Wallace[18] in New Guinea, is highly remarkable as the males are furnished with horns of which the females are quite destitute The horns spring from beneath the eyes and curiously resemble those of a stag being either branched or pal m t d T [illegible] s equal the [illegible] be thought [illegible] one species [illegible] edged with black, with a pale central stripe and as these insects have altogether a very elegant appearance it is perhaps more probable that they serve as ornaments That the males of some Diptera fight together is certain Prof West Wood [19] has several times seen this with the Tipulæ. The males of other Diptera apparently try to win the females by their music H Müller[20] watched for some time two males of an Eristalis courting a female they hovered above her and flew from side to side making a high humming noise at the same time Gnats and mosquitoes (Culicidæ) also seem to attract each other by humming and Prof Mayer has recently ascertained that the hairs on the antennæ of the male vibrate in unison with the notes of a tuning fork within the range of the sounds emitted by the female The longer hairs vibrate sympathetically with the graver notes and the shorter hairs with the higher ones. Landois also asserts that he has repeatedly drawn down a whole s [illegible]

[illegible] in most other insects in accordance with their highly-developed nervous system [21]

Order HEMIPTERA (Field Bugs) —Mr J W Douglas who has particularly attended to the British species has kindly given me an account of their sexual differences The males of some species are furnished with wings, whilst the females are wingless the sexes differ in the form of their bodies elytra antennæ and tarsi but as the signification of these differences is unknown they may be here passed over The females are generally larger and more robust than the males With British and as far as Mr Douglas knows with exotic species, the sexes do not commonly differ much in colour but in about six British species the male is considerably darker than the female and in about four other species the female is darker than the male Both sexes of some species are beautifully coloured and as these insects emit an extremely nauseous odour their conspicuous colours may serve as a signal that they are unpalatable to insectivorous animals In some few cases their colours a[illegible]

[illegible] is said to be effected by the movement of the neck within the prothoracic cavity According to Westring *Reduvius personatus* also stridulates But I have no reason to suppose

[17] *Transact Linnean Soc* vol xxvi 1868 p 96
[18] *The Malay Archipelago* vol ii 1869 p 313
[19] *Modern Classification of Insects* vol ii 1840 p 526
[20] *Anwendung* &c *Verh d n. V Jahrg* xx p 80 Mayer in *American Naturalist*, 1874 p 236

[21] See Mr B T Lowne [illegible]

[illegible] t d sappear

[22] Westwood *Modern Classification of Insects* vol ii p 473

that this is sex l haracte cepting that th social insects the e seems t be n use f sound prod ing o gans unl ss t be as sexual call.

Ord H MOPTERA —E ry e who has nd red n a trop al f t m st ha been astonisl ed t th di mad by the male C'cadæ. The f mal s are m te as the Grec poet Xenarchus says, H ppy the ci adas l e since th y all ha e cel ss wi Th n ise thus mad co ld be plainly h ard n bo rd th B gl wh an h ed t a q art f

l ht so g t rs Th sound ac

tuat is prou eu

b an set to act by a pecial m scl In th h g nsect, whil t trid l t g, this m m bra can b see t brat and th d ad insect tl prope so nd h rd f th m scl h l ttl dried and hard ed p lled w th the po t f p I th f mal th wh l compl mus cal pp tus i prese t b t is m h less d l ped than th mal and

direct ns This I bel t b th m rt al mm ns from th m l Stand g in th ck l t t pro t abo t as h gh as my l ad l re l nd ed w re ro d m I bse ed tl f mal com g ro d th d mming les H dds. Th seaso (A g 1868) d f pear tree my gard prod ed bo t

fifty larvæ f C prui osa and I se eral times n t ced the f m l s t alight n ar a male while h was uttering his clangi g notes. Fritz Mül le writ s t m f om S Brazil that l e has oft n h t ned t a musical o te t b tween two or three male f a pecie with a particularly l d ce se ted t a cons d rable d st ce from each tl r as soon as one had fini l d l is song an th r imi ed t ly begun, and tl en n th As th re so much r alry betwee th males, t s probabl th t the f mal s n t nly find th m by the r sounds, b t that l ke f male birds, th y are ted o all red by the male w th th m t ttract o ce

I h e n t he rd f any w ll ma ked case f rn mental diff rences b tween th se es f the H mopt r Mr Douglas i f rms n tl t th re are three Briti l pec s, n wl cl the mal i black r marked w th black bands, wl l t th fem le are p l -col ured obsc re

Ord r ORTHOPTERA (C ick t nd Grass- l rs) —Tl mal in the th ee saltat al f

unm al n to the h man r so that th Ind ans n th Amazon keep th m in wicker c ges. All obser s gree that the so ds se e tl r t call te tl m te f males. W th re pect t th m gr tory locu ts of R s- a, K rt l as gi n[23] an int re ting case f select n by tl f m l f a m l Tl m les f thus pecu (I achytyl m gratorius) wl lst co pled with the f male t d late from anger l l y if pp oached by th mal Th h use-cri k t wh n rprised t n ght us s ts ce t warn t f ll w [24] In N rth America th Katy d d (Platyphyll m arum f th Locustidæ) is desc bed[25] as m nt g n tl ppe b an h s f tree and in th e ning beginning hi n y babble, while ri al n t iss f m tl n gl bouring trees, and th g reso nd th tl all f Katy-did

[19] These particulars re tak from W t ood Moder Cl ssifi f Insects l 1840 p 422. See also the Fulgoridæ, K by d pe ce Int oduct l p 401

[20] Zeitsch ft f wissensch ft Zoolog B 1867 152 158.

[21] T nsact ons of the New Z aland Institute, l 1873 p 286

[22] I am debted t M Walsh for h g se t m this tract from A J nal f the Doi g C d ept mdemi by D Hartman.

[23] L G ld g T nsact f the L nne Society l, 1875 p 262.

[24] Harris, Insect f N w E gl nd, 1842, p. 128.

she-did the live long night Mr Bates in speaking of the European field cricket (one of the Achetidæ) says the male has been observed to place himself in the evening at the entrance of his burrow and stridulate until a female approaches when the louder notes are succeeded by a more subdued tone whilst the successful musician caresses with his antennæ the mate he has won [31] Dr Scudder was able to excite one of these insects to answer him by rubbing on a file with a quill [32] In both sexes a remarkable auditory apparatus has been discovered by von Siebold situated in the front legs [33]

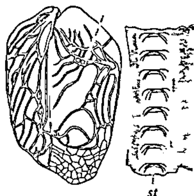


FIG 11 *Gryll s ca p t* (fro Land)
Right ha d f gu e u d r de of part f a
wi g n h gn fied sho ing
th t th (*st*) L ft h d figure upper sur
f f g c th tl e pr ject ng
m th n r h ch th te th
(*st*) a ped

In the three families the sounds are differently produced In the males of the Achetidæ both wing covers have the same apparatus and this in the field cricket (*Gryllus campestris* fig 11) consists as described by Landois [4] of from 131 to 138 sharp transverse ridges or teeth (*st*) on the under side of one of the nervures of the wing-cover This toothed nervure is rapidly scraped across a projecting smooth hard nervure (*r*) on the upper surface of the opposite wing First one wing is rubbed over the other and then the movement is reversed Both wings are raised a little at the same time so as to increase the resonance In some species the wing-covers of the males are furnished at the base with a talc like plate [34] I here give a drawing (fig 12) of the teeth on the under side of the nervure of another species of Gryllus viz *G domesticus* With respect to the formation of these teeth Dr Gruber has shown[36] that they have been developed by the aid of selection from the minute scales and hairs with which the wings and body are covered and I came to the same conclusion with respect to those of the Coleoptera But Dr Gruber further shews that their development is in part directly due to the stimulus from the friction of one wing over the other

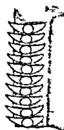


FIG 12 T eth f N rvure f *G yll s domes i cus* (f m La d is)

In the Locustidæ the opposite wing-covers differ from each other in structure (fig 13) and the action cannot as in the last family be reversed The left wing which acts as the bow lies over the right wing which serves as the fiddle One of the nervures (*a*) on the under surface of the former is finely serrated and is scraped across the prominent nervures on the upper surface of the opposite or right wing In our British *I hasgon a viridissima* it appeared to me that the serrated nervure is rubbed against the rounded hind-corner of the opposite wing the edge of which is thickened coloured brown and very sharp In the right wing but not in the left there is a little plate as transparent as talc surrounded by nervures, and called the speculum In *I ph ppiger vitium* a member of this same family we have a curious subordinate modification for the wing covers are greatly reduced in size but the posterior part of the pro-thorax is elevated into a kind of dome over the wing-covers and which

[31] *The Nat ralist n the Am zons* vol 1863 p 252 Mr B tes gi y t ti g d cuss n n

tory L xi Apr l 1868
[33] *No r u M el d l at C mp* French tr nslat. t m 1 1850 p 567
[4] *Z itschrift fur wiss nsch ft. Zoolog* B xvi 1867 s. 117

[34] W twood *Mod Cl fi t f Insects* L i. p 440
[36] Ube d r T pp t ler Loc t d n B t g D us *Z tschrift f wissensch ft Zool g* B 1872, p. 100

has prob bly the ffect of i creasing the sound.

W thus see th t th mus cal pp ratu s m re diff t ted pecı l ed n th Locustidæ (which in I d I bel th m t po rful perf rm rs n the Orde) than in the Ach tidæ, in whi h both w -co e s h th same tru t re and th same fun t [38] Lan d is, how r d tected n f th Locustdæ nam ly in Dect cus, sh rt and narrow

tary teetl ar comm nly f und n tl e inf i r s rface f tl gl t wing By wh t tep tl t i n tl e Ach t dæ ongi

ana t a gr ting sound as is n w tl ase with ti w g-co s of th f males [39] A grati g sou l thus occası nally and ccide tally made by

F G. 15 *Chloroc l T na* (from B tes) *b* Lobe f ppos l g-co ers.

row f mall t th d m ts, th tl m l f t served th r so l ttle as a infen rface f tl ght in -c wl h l -c ll t th f m l s, gl t ad ly h und l th th and n u ed as th b n t ns fied th gh se u l sel t n by bow I bse ed th sam d m ta y t t re th und d f th ght wing-co *I hasg rıd m* H ce w m y f th co fid ce tl at th Loc tidæ d sce l d from f m in wh ch as tl isti g Ach t dæ b th w g-co had se ted u th u d face d co ld be ind ff re tly sed as th b w b t th t th Locust dæ th t w g-co rs grad ally bec m d ff t t d d pe fected th prin pl f th d [1] bour tl to act cl ly as th bow and tl th as th fiddl D Grube t k th sam w and has sh w th t rudim n

p eced g fam l Th i n surface f the fem (fig 14) fur ished w th l gi t d l w f m t l gant, lan t h ped last c teeth from 8 to 93 i n mb [40] and th se ar sc ped across tl h rp project g rvu s th w g-co s, wl ch re tl mad to b t d eso d H rris say

[38] West ood *Modern Clas ficat f Insects* I. p 453

La d is, *Zeitsch ft f wiss nschaft. Zoolog* B xvii, 1867 ss. 121 122.

that when one of the males begins to play he first bends the shank of the hind leg beneath the thigh where it is lodged in a furrow designed to receive it and then draws the leg briskly up and down He does not play both fiddles together but alternately first upon one and then on the other In many species the base of the abdomen is hollowed out into a great cavity which is believed to act as a resounding l ' African ge we meet w .. tion in the males a small notched ridge projects obliquely from each side of the abdomen against which the hind femora are rubbed [1]

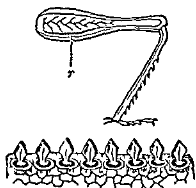


FIG 14 Hind l g f *Stenobothr s pr to m* r the t d l ting ridge l w figure the teeth f r i g the ridg uch mag fed (from Lan l is)

As the male is furnished with wings (the female being wingless) it is remarkable that the thighs are not rubbed in the usual manner against the wing-covers but this may perhaps be accounted for by the unusually small size of the hind legs I have not been able to examine the inner surface of the thighs which judging from analogy would be finely serrated The species of Pneumora have been more profoundly modified for the sake of stridulation than any other orthopterous insect for in the male the whole body has been converted into a musical instrument, being distended with air like a great pellucid bladder so as to increase the resonance Mr Trimen informs me that at the Cape of Good Hope these insects make a wonderful noise during the night.

In the three foregoing families the females are almost always destitute of an efficient musical apparatus But there are a f w exceptions to this rule for Dr Gruber has shewn that both sexes of *Ephippiger vitium* are thus provided though the organs differ in the male and female to a certain extent. Hence we cannot suppose that they have been transferred from the male to the female as appears to

(

Locustidæ (but not, according to Landois, in Decticus) the females have rudiments of the

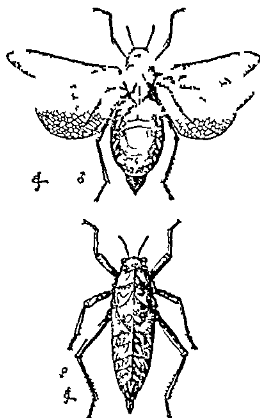


FIG 15 I i u a (f ; een na i the Br t l Mus um) Upper figure mal l r figure f m le

stridulatory organs proper to the male from whom it is probable that these have been transferred Landois also found such rudiments on the under surface of the wing-covers of the female Achetidæ and on the femora of the female Acridiidæ In the Homoptera, also the females have the proper musical apparatus in a functionless state and we shall hereafter meet in other divisions of the animal kingdom with many instances of structures proper to the male being present in a rudimentary condition of the female

Landois has observed anoth important

[1] Westwood *Modern Classif* at n l p 462.

fact, namely that in th females f th Acri didæ, the trid latin teeth n th f mora remain thro gh t lif in th sam cond t n in which th y first appear during th larval stat in both sexes. In th mal s, n th th hand they becom f rth r d loped and acquire their perfect truct re at the last moult, whe th insect is mature and ready t breed.

From th facts n w gi n we see th t th means b which the males of tl Orthopt ra produce th ir sounds are xtrem l d rsified, and are alt g th diff re t from those em ployed b th H mopt ra B t throu h t the animal king d m w ft n find the sam object gained by th mo t di rsified means this seems d to th wh l o ganisat n h ing und rgo e m ltifarious changes n th course of ges, and as part aft part aried different ariati ns w re taken ad anta e f for th m g ral purpose Th d rsit of

... ...

fossil insect in th D man f rmat of N w Brun wick, which furn hed w th th w ll-known trmpan m stridulating pparatus of tl male Locustidæ Th insect, th gh in most respects related to th N uropt ra, p pears, as is so ften th case w th rs ancie t forms, t co ect th tw related Ord rs f the Neuropt ra and Orth pt ra.

I ha b t littl more to sa n th Orthoptera. Som of the pecies are ry p gnaci us ben tw male fi ld-crick ts (*Gryllus campe tris* are confined to th th fight till ne kil the ther and th species f mantis are described as manœ n g w th thei sw rd lik fro t limbs, lik hussars w th th sabres. The Ch nese keep these nsects in little bamboo cages, and match them lik gam -cocks.

With respect to col ur some exotic locusts are be tifully ornam nted tl e po t rior wings being marked with red blue and black but as thro gh ut tl e Orde the sex s rarely diff r much in col ur it is n t probable that they w th r bri ht t ts t sexual select on Con p cu u colo rs m be f use to tl se insects, by gi g n t ce th t th are unpalatable Tl t has been observed that a b ht coloured Indian locu t was in ariabl rejected wh n off red to birds and lizards. Some cases, howe are kn wn of sexual diff re ces in colour this Ord r The male of an Am rican crick t is described as being as wh te as rs whilst th f male varies from almost whit t greenish y llow o d sky Mr Walsh inf rms m that th ad lt mal of *Spectrum fem rat m* (o e f th Phasmidæ) "is f sl n ing brownish ell w colou th ad lt f n al bein f a d ll opaque cin reous brown the y g of both se es bein green. Lastl I may m t n that tl mal f n curious kind f cr k t is furnished w th a long m m branous ppendag which falls er th face lik il b t what ts use may be is n t kn wn.

Ord NEUROPTERA. —Little need h re be said e cept as t col In th Eph m ridæ th se es oft d ff sli htly in th bscure tints b t t is not probable that th males are thus rend red ttract to the f mal s. Th Libell lidæ o dragon flies, are orna m nted with spl ndid green, bl ll w and rmili n m tallic tints and th sexes oft n diff Thus, as Prof W twood marks, the males f som of th Agri idæ are of a rich bl w th black ings, whilst th f males are fin green with col urless wings." B t in *Agrion ramburi* these colours re xactly re rsed in th two sexes. In the ext n N Am rican g n f H tærina, the males alo e ha a bea tiful carmin pot t the base f

Landois has rece tly found in certai Orthoptera rudimentary structures close y similar t the sound-producing org ns in the Homoptera nd this is surprisin fact See *Zeitschrift fur wissenschaft Zoolog* B xx Hef 3 1871 p 348

Transactions Entomological Society 3rd series, vol ii *Journal of Proc ed* p 117)

Westwood, *Modern Classification of Insects*, vol p 427 for ckets p 445.

Mr Ch. Horne, *Proceed g f th Ent mological Society* M y 3 1869 p xii.

The *Œcanthus* alis Harris, *Insect of New E gl nd*, 1842, p 124 The tw se es of *Œ pellucidus* of Europe differ as I hear from Vict Carus, n nearly th sam ma

Plat blemnus Westwood, *Modern Class ficat n*, ol i, p. 447

B D Walsh, the Pseudo-neuropt ra of Illi nois, in *Proceed of the Ent mological Society f Philadelph a*, 1862, p 361

Modern Classification, vol p. 3

W lsh, *ibid* p. 381 I am ndebted t this naturalist for the follo in f cts Hetæri a, Anax, and Gomphus.

each wing In *Anax junius* the basal part of the abdomen in the male is a vivid ultramarine blue and in the female grass green In the allied genus Gomphus on the other hand and in some other genera the sexes differ but little in colour In closely allied forms throughout the animal kingdom similar cases of the sexes differing greatly or [illegible] t at all [illegible] there is [illegible] he sexes [illegible] it is often difficult to say which is the more brilliant and the ordinary coloration of the two sexes is reversed as we have just seen in one species of Agrion It is not probable that their colour in any case have been gained as a protection Mr MacLachlan who has closely attended to this family writes to me that dragon flies—the tyrants of the insect world—are the least liable of any insect to be attacked by birds or other enemies and he believes that their bright colours serve as a sexual attraction Certain dragon flies apparently are attracted by particular colours Mr Patterson observed [33] that the Agrionidæ of which the males are blue settled in numbers on the blue float of a fishing line whilst two other species were attracted by shining white colours

It is an interesting fact first noticed by Schelver that in several genera belonging to two sub families the males on first emergence from the pupal state are coloured exactly like the females but that their bodies in a short time assume a conspicuous milky blue tint owing to the exudation of a kind of oil soluble in ether and alcohol Mr MacLachlan believes that in the male of *Libellula depressa* this change of colour does not occur until nearly a fortnight after the metamorphosis when the sexes are ready to pair

Certain species of Neurothemis present according to Brauer [34] a curious case of dimorphism some of the females having ordinary wings whilst others have them very richly netted as in the males of the same species Brauer explains the phenomenon on Darwinian principles by the supposition that the close netting of the veins is a secondary sexual character in the males which has been abruptly transferred to some of the females [illegible] of as generally occur to all of them Mr MacLachlan informs me of another instance of dimorphism in several species of Agrion in which some individuals are of an orange colour and these are invariably females This is probably a case of reversion for in the true Libellulæ when the sexes differ in colour the females are orange or [illegible] ters it would not be surprising that a tendency to vary in this manner should occur in the females alone

Although many dragon flies are large powerful and fierce insects the males have not been observed by Mr MacLachlan to fight together excepting as he believes in some of the smaller species of Agrion In another group in this Order namely the termites or white ants both sexes at the time of swarming may be seen running about the male after the female sometimes two chasing one female and contending with great eagerness who shall win the prize [35] The *Atropos pulsatorius* is said to make a noise with its jaws which is answered by other individuals [36]

Order HYMENOPTERA — That inimitable observer M Fabre [37] in describing the habits of Cerceris a wasp like insect remarks that fights frequently ensue between the males for the possession of some particular female who sits an apparently unconcerned beholder of the struggle for supremacy and when the victory is decided quietly flies away in company with the conqueror Westwood [38] says that the males of one of the saw flies (Tenthredinæ) have been found fighting together with their mandibles locked As M Fabre speaks of the males of Cerceris striving to obtain a particular female it may be well to bear in mind that insects belonging to this Order have the power of recognising each other after long intervals of time and are deeply attached For instance Pierre Huber [illegible] some ants [illegible] some [illegible] and [illegible] after an interval of four months [illegible] other which had formerly belonged to the [illegible] Had they [illegible] they would have fought together [illegible]

33 Transactions Ent Soc vol 1 1836 p lxxx
34 See abstract in the *Zoological Record* for 1867 p 450

35 Kirby and Spence *Introduct to Entomology* [illegible] 1818 p 35
36 [illegible] p 104 [illegible]
37 [illegible] *Nat Hist Review* April 1862 p 122
38 *Journal of Proc of Entomolog Society* Sept 7 1863 p 169

in battl th ants n th same d sometimes ttack ach th r in th g al con fus n, b t they soo percei e the r mistake, and the ant sooth s th the [58]

In this Ord sl ht d ff rences n colour according t sex, are comm n but consp c s diff rences are rare except n tl f m ly of bees t both se es f ce tain gro p are so brilliantly col red—f instance Chry s, in wh ch mih n and metall c greens preail—th t w are t mpted t tt b t the result t sexual select n. In th Ichn um dæ according to M W lsh [59] the m les are almost m rsally l ght r-colou ed than the f mal s. O th th hand tl T thred inidæ th mal ar g ally dark than the f males. I th S n dæ th se frequ tly diff th s th mal f S j e c is band ed with orang whilst th f mal dark p pl b t t is d ffi lt t say wh ch se is th m re rn m ted I T em ol mbæ th f mal is m h bright col red than tl mal I am af rmed by M F Sm th th t th mal ants f se ral pec are black, th f males bein t t ceo s.

I th family f bees, pecially in th sol

b as ll as Apath s, in ch m re arı bl in colo than tl f m l s. In A thoph ra d th mal s f a rich f l s-brow hilst th f mal is quit black so are th f males f se ral pec es f X locopa, th m l bei g bright y llow On th th hand th f mal f som speci s, as f A dren f l are m h bright col red than th males. Such diff re ces col hardl b co ted f t th mal being d f cel ss nd th req n g prot ct hilst th f mal are ll d f nded b tl tings. H M ll [60] l has part cularl tt ded t th h b ts f bees ttrib tes these diff re ce in col ur in h f p rt to se ual select Th t bee h kee perceptı f col is certain. H say tl t th m l search g l and fi ht f th po sess f th f mal and h account thro gh h co t t f th mand bl f th male be g in certai peci larg tl n tl se of tl f ial s. I som case tl m les re far m re m ro th th f mal s, th arly in tl e season, o at all tim s and places, or locally wh reas the f male in the cases are appare tly n e cess In som peci s tl m re b a t f l m l s ppear to hav beer lected by tl f mal and in thers th n re b auti f l fem le by tl e mal Consequ ntly in certain ge ra (Müll r p 4) th m le f the se al pec d ff m h i appear nce l l t tl f male e almost i di tinguisl

seg ts, d I fi d th t tl se urface are marked w th y fin co centri r dge b t so is th project g tl ac c collar int wl ch the h ad art l t s, and th collar wh n se t l ed w th tl po t of a needl em ts tl e prope sound It is ther rprising th t both se b ld h e tl powe f trıd l ti g as th male winged and tl f mal wingl ss. It n t n tl t bee p ss certain mot ns, as f ang by th t f th ir h m ming and cord g t H Müller (p 80) th mal f som pec es mak a pec l ar gi g n ise whilst pursuing th f m les.

m l bee f rt l sed by mal wh ch prese ted som

[58] I ll be Recherch su le Mœu de Fourmis I I pp 150 165

[59] I oc ed g of the Ent molog al ociety f Philadelph 1866, pp 238, 239

[60] A d g d Darw sche I hre uf Bennen, V erh d n I Jah g ix

gr df th Th acq irem t f w h ract rs by the t d w k bees is m ch m re d fficult ase b t I ha d ured t h w my O g f Specie h these ter le be g are bjected t th po er of tural selecti n.

[61] Q ted by West ood Moder Classifi at f Insects I p 214

each wing In *Anax junius* the basal part of the abdomen in the male is a vivid ultramarine blue and in the female grass green In the allied genus Gomphus on the other hand and in some other genera the sexes differ but little *in colour In closely allied forms* throughout the animal kingdom, similar cases of the sexes differing greatly or very little or not at all, are of frequent occurrence Although there is so wide a difference in colour between the sexes of many Libellulidæ it is often difficult to say which is the more brilliant and the ordinary *coloration of the two sexes is reversed* as we have just seen in one species of Agrion It is not probable that their colours in any case have been gained as a protection Mr Mac Lachlan, who has closely attended to this family writes to me that dragon flies—the tyrants of the insect world—are the least liable of any insect to be attacked by birds or other enemies, and he believes that their bright colours serve as a sexual attraction Certain dragon *flies apparently are attracted by particular* colour Mr Patterson observed[52] that the Agrionidæ of which the males are blue settled in numbers on the blue float of a fishing line whilst two other species were attracted by shining white colour

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Although many dragon flies are large, powerful and fierce insects, the males have not been observed by Mr MacLachlan to fight together excepting as he believes, in some of the smaller species of Agrion. In another group in this Order namely the termites or white ants both sexes at the time of swarming may be seen running about, the male after the female sometimes two chasing *one female and contending with great eager*ness who shall win the prize[54] The *Atropos pulsatorius* is said to make a noise with its jaws which is answered by other individuals.[55]

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52 *Transactions E t. Soc.,* l. i., 1836 p lxxxi.
53 See abstract in th *Zoological Record f* 1867 p. 450.

54 Kirby and Spence, *Int oduction t Entomology* l. 1818 p 3
55 H uzeau, *Et d Le Facult Mentale des* *f m x t* p 104
56 See n
F b n \
57 *J nal)* Sept. 1863 p 169

in battle, the ants on th sam de sometimes ttack ach oth r in th g neral con fusion, b t they soon perce th ir mistak and the n ant sooth th oth

In this Order sl ht d ff re ces in col ur according t sex, are comm n, b t consp u u diff re ces are rare cept in th family f bees t both se es f certain group ar so b illiantly col ured—f instance n Chrys s, in wh ch rmilio and m talli greens pre vail—that we ar tempted to ttribute th result to sexual selecti n. In th I hne m n dæ according to Mr Walsh[20] tl m l are almo t ni rsall l ght -coloured than tl f males. O th th hand, in th T nthred nidæ th males are g rally darke tl an tl f males. In the S ricidæ th se frequ tly differ th th mal f S j en s band ed with range whilst tl femal is d k p ple b t t is diffi lt t sa which sex th m re rnam ted I T emex ol mbæ tl f male is m h bright col oured than the male I am inf rmed b M F Smith, th t th mal ants f se l pec are black, th f males bein testaceous.

I th family f bees, especially in th sol tary peci s, as I hea from th sam n tom logist, th se ft diff in colo Th males are g rally th bright and in B m bus as ll as in Apath s, in h m ariabl in col than th f mal s. I A thopho a th mal is f n h ful s-brown hil t the f ma is q t black so are th f males f se eral pec es f X locopa, th males being bright ll w On th ther hand th f mal f som spec s, as f A d ana f l a, are m h bright col red than th mal s. Such diff rences col ca hardl b ac co ted f b tl m l be g d f cel ss and th req ring prot ct lst th f mal are ll i l nd d l tl tings. H Mull[21] ho has part cula l tt ded t th b b t f bees, ttrib t these diff rence in col in ch f part to se ual select That bee ha kee percepti f col is certain. H says that th mal se rch eag l and fi ht f th possess f th f males and h accounts thro gh h co te t f th mandibl f th males be ng in certai peci larg than th se of tl f male In som cases tl males are far more m ro tha th f males, th arly in th season r at ll tim s and places, or l r s th f male n othe cases are

ful f mal by th male C nsequent u certain g ra (M ller p 4) th male of the se e al pec es d ffe m h n appear ce wh l t th f males re alm t distingu h bl n th g ra the re erse occu s. H Mull beli e (p 8) that tl col urs gained by e sex thr gh se ual selecti n ha often bee n ll d rree to the tl

t

th mai

M t lla E pea makes a tr d lating n ise and accord g to G re u[22] both se es l a th pow H attrib t the so d to the f t f tl third and preced g abd m al

th l ad art l t and this collar wl n scrat hed w th th po t f a needl m ts tl e prope sound It rath r rprising that both se e sh ld ha th pow f tridulati g as th m l is w ged and tl f mal wingless. It is tori that bee press certain mo ti ns, as of ang by th t n f th hum ming and accord g to H Mull r (p 80) th mal s f som peci make pecul ging noise whilst p g th f mal s.

m l bee f rtilised b male, hi h prese ted som

[20] H ber Recherche le Mœu d Fourmis 181 pp 150 165

[21] roceed g of the Entomolog al Society f Philadelphia, 1866 pp 238, 239

[22] An dung ler Darw sche Lehre uf B enen, I erh d n 1 Jahrg xix.

gr lf th Th acquirem t of w h ra t rs by the t nl w ker bees is m ch m re difficult case b t I ha dea ured to sh w my O g f Specie h w these terile be gs are ubjected t th power of natural selecti n.

[22] Q ted by West ood Moder Classifi atio f Insects i. p 214

Order COLEOPTERA (Beetles) —Many beetles are coloured so as to resemble the surfaces which they habitually frequent and they thus escape detection by their enemies Other species for instance diamond beetles are ornamented with splendid colours which are often arranged in stripes spots crosses and other elegant patterns Such colours can hardly serve directly as a protection except in the case of certain flower feeding species but they may serve as a warning or means of recognition on the same principle as the phosphorescence of the glow worm As with beetles the colours of the two sexes are generally alike we have no evidence that they have been gained through sexual selection but this is at least possible for they have been developed in one sex and then transferred to the other and this view is even in some degree probable in those groups which possess other well marked secondary sexual characters Blind beetles which cannot of course behold each other s beauty never as I hear from Mr Waterhouse jr exhibit bright colours though they often have polished coats but the explanation of their obscurity may be that they generally inhabit caves and other obscure stations

Some longicorns especially certain Prionidæ offer an exception to the rule that the sexes of beetles do not differ in colour Most of these insects are large and splendidly coloured The males in the genus Pyrodes[63] which I saw in Mr Bates s collection are generally redder but rather duller than the females the latter being coloured of a more or less splendid golden green On the other hand in one species the male is golden green the female being richly tinted with red and purple In the genus Esmeralda the sexes differ so greatly in colour that they have been ranked as distinct species in one species both are of a beautiful shining green but the male has a red thorax On the whole as far as I could judge the females of those Prionidæ in which the sexes differ are coloured more richly than the males and this does not accord with the common rule in regard to colour when acquired through sexual selection

A most remarkable distinction between the sexes of many beetles is presented by the great horns which rise from the head thorax and clypeus of the males and in some few cases from the under surface of the body These horns in the great family of the lamellicorns, resemble those of various quadrupeds such as stags rhinoceroses &c. and are wonderful both from their size and diversified shapes.

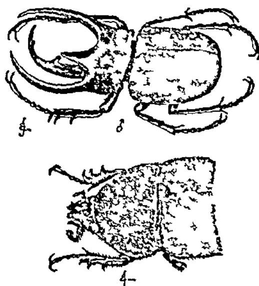
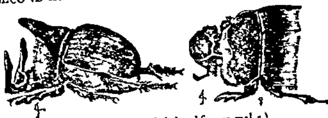


Fig 16 *Chal atl* Uppe figure le (reduced) lo r figure f ale (t ze)

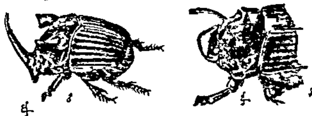
Instead of describing them I have given figures of the males and females of some of the more remarkable forms. (Figs. 16 to 0) The females generally exhibit r i l

... other hand the horns are nearly as well developed in the female as in the male *Phanæus lancifer* and only a little less well developed in the females of some other species of this genus and of Copris I am informed by Mr Bates that the horns do not differ in any manner corresponding with the more important characters the difference between the several subdivisions of the f m h thus within the same section of the genus Onthophagus,

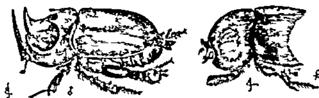
sp ... r ... in ... 'e ... in ... x s f b etl s h by nd Sp ce (*I d od t t E d mol g* ... p 501) ... m nt ... C ntl rs, M loe Rh g m a ... th *Lept a t t* ... th m l f the ... be g t s t cou w th bl ck th d th f l f a d ll ed ll r fl ese t l tt beetl b l g to the f ly of l g co ns. M s. R. Trm d ... W ... ...



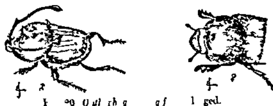
F G. 17 C pr nsnd (Left h d figures, mal s.)



Fi 18 Ph nau f



F 19 D pel cu t n



I 20 O ul ph g g f l ged.

th re are peci wl ch l gl l rn and th l h h t

I lm t all case th l rn are m kabl f tl cess anab l ty so that g ad ted se es can be f rmed f m tl m t l ll d l ped m l t th so d g t tl t th y can b rely b distingui l ed from th f al M W lsl[63] f d th t m I h nu rn f tl h w re thr ce as l g m som mal th M B tes, aft m g abo h dred mal f O tho- p j y fer (fig 20) tl gl t tl t h had t last disco red pec m wl l th h rns l l t n b t f rtl researcl pro ed tl n trar

Th ext aord ary size f th h rns, and th w d ly d ff rent tructu m l sely all ed f ms, indicate that they ha been f rmed f some purpose b t th ir excess e ari b l ty in th males f th same peci l ad t th nf rence th t tl purpose cann t b f d finit nat re Th h rns do not how marks of fri t as if used f any rdin ry w k Som utl ppose[64] th t as th mal wand abo t m ch m re than th f mal s, tl y equire h rn as d f ce gain t th m b t as th horns are ft n bl t th y d n t seem w ll ad pted f def ce The m t b co jecture is th t th y are used by th m l f r fighti g tog th b t th

63 Proceed g f the Ent olog l Society f Ph l delphia, 1864 p 228

64 K by d pe ce Int od t to Ent mology l. p. 300

males have never been observed to fight nor could Mr Bates after a careful examination of numerous species find any sufficient evidence in their mutilated or broken condition of their having been thus used If the males had been habitual fighters the size of their bodies would probably have been increased through sexual selection so as to have exceeded that of the females but Mr Bates after comparing the two sexes in above a hundred species of the Copridæ did not find any marked difference in this respect amongst well developed individuals In Lethrus moreover a beetle belonging to the same great division of the lamellicorns the males are known to fight but are not provided with horns though their mandibles are much larger than those of the female



FIG 21 *On t f cif* mal iewed fr m b ne th

The conclusion that the horns have been acquired as ornaments is that which best agrees with the fact of [illegible] been so [illegible] ed —as [illegible] ie same [illegible] and by their extreme diversity in closely allied species This view will at first appear extremely improbable but we shall hereafter find with many animals standing much higher in the scale namely fishes amphibians reptiles and birds that various kinds of crests knobs horns and combs have been developed apparently for this sole purpose

The males of *Onitis furcifer* (fig 21) and of some other species of the genus are furnished with singular projections on their anterior femora and with a great fork or pair of horns on the lower surface of the thorax Judging from other insects these may aid the male in clinging to the female Although the males have not even a trace of a horn on the upper surface of the body yet the females plainly exhibit a rudiment of a single horn on the head (fig 22 *a*) and of a crest (*b*) on the thorax That the slight thoracic crest in the female is a rudiment of a projection proper to the male though entirely abs [illegible] ns [illegible] of [illegible] [illegible] ar slight crest on the thorax and the male bears a great projection in the same situation So again there can hardly be a doubt that the little point (*a*) on the head of the female *Onitis furcifer* as well as on the head of the females of two or three allied species is a rudimentary representative of the cephalic horn which is common to the males of so many lamellicorn beetles as in Phanæus (fig 18)

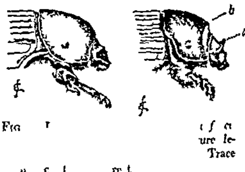


FIG [illegible] *f* *a* ure le- Trace [illegible]

The old belief that rudiments have been created to complete the scheme of nature is here so far from holding good that we have a complete inversion of the ordinary state of things in the family We may reasonably suspect that the males originally bore horns and transferred them to the females in a rudimentary condition as in so many other lamellicorns Why the males subsequently lost their horns we know not but this may have been caused through the principle of compensation owing to the development of the large horns and projections on the lower surface and as these are confined to the males the rudiments of the upper horns on the females would not have been thus obliterated

The cases hitherto given refer to the lamellicorns but the males of some few other beetles belonging to two widely distinct groups namely the Curculionidæ and Staphylinidæ are furnished with horns—in the former on the lower surface of the body [48] in the latte [illegible] ad and of the [illegible] e same [illegible] just as we have seen with the lamelli

[48] K by d pe ce *I it od ct to E t mology* I p 329

corns. In Siagonium w ha e a case of di morphism, f the males an be di ided int two sets, diff ring gre tl in the size f th bodies and in th d lopment f th ir l rns, without intermediate grad tions. In a species



FIG. 23 *Bled us taurus*, magnified. Left hand figure male right hand figure female.

of Bledi s (fig. 23) also bel nging to th Staph linidæ Professo Westwood tates that male pecimen can be f und in th sam localit in hich th central h rn of th thorax is ery larg b t th h rns f th head q t rudime tal and th rs, in whi h th th racic horn is m h short whil t th protubera ces on th h ad are l g * H re w ppare tly ha case of compensation, wl h throw light that j t gi n, f th pposed loss f th ppe horns b th males f O tis.

Law f Battle.—Som mal beetl s, wh ch seem ill-fitted f fighti g, ne rth less gage in conflicts fo th possess f th f males. M Wallace* saw tw mal f *Lepto hynchus ang status* lin ar beetle w th much lo gated *rostrum* figl ting f a f mal wh tood lose b bu. t h boring Th y pushed at each th with th ir ro tra, and lawed and thumped ppare tly in th gre t trag The maller male h w soon an w acknowledg himself anquished In som f w cases mal beetles are w ll ad pted f

from th p pal tat abo t week bef re th the sex, so that se ral may ften be seen pursuing th sam f male At this seaso th y eng g in fi rce conflicts. Wh M A H. D is nclosed tw mal with f mal in box, the lar male se rely p nched th

maller o until he resigned his pretens ons. A fri nd inf rms m that wh n a bo he often p t th males t th r t see th m fight, and he not ced that th w re m ch bold and fi rce than tl females, as w th tl h gh ani mals. Tl males would seiz h ld f his fing if h ld n fro t f th m h t n t so the f mal s, alth gl th h tro g j ws. The males of many of the Lucanidæ as w ll as of the abo m nti ned Lep- t h n h s, are larg r an l m re pow rf l insects than th fe males. Th tw sexes f *Lethrus phalot s* (on f the lamellicorns) inhab t the sam b rrow and tl mal has larg r mandibles than th f m l If during th breeding season, a trange

is kiled is

lam llicorn beetl the *Ateu hus cicatricosus* h pairs, and seem much attached to ch th th male xcites th f males to roll th

are trem l ariabl both in size and truc- ture and in this respect resembl th horns n th h ad and th rax f many male lam lli corns and Staph linidæ A perfect seri s can be f rmed from th best provided to the worst pro ided o d g rat males. Alth gh the mand bles f th comm n tag beetl and probably f many th speci s, are used as ef fi t weapons f fighting, t is do btf l wh th th ir gre t size can thus be accounted f W ha seen that th y are used by th *L us laphus* of N Am rica f seizing th f mal As th y are so con p cu us and so ele- gantl branched and as owing to ther gre t l gth th y are n t w ll ad pted f pinching, the u p ci n has rossed my mind that th y may in additi n serv as an ornam nt, lik th h rns th head and th rax of th an us peci abo described. Th male *Chiasog a*-

* *Modern Classification of I ects* ol. i., p. 1 2. Siagonium, p 1 2. I the British Museum I ticed one male specime of iagon um termediat nd ion so that the dimorphism is not trict.

* *The Malay Arch pelago*, ol. ii. 1869 p. 276. Riley urth I port on Ins cts f Misso ri, 1873 p. 115

Entomological M gazine vol. i., 1833 p 82. See also the conflicts of this species, Kirby d pence ibid., vol. iii., p. 314 d West ood, ibid., ol. i., p. 187

*Quoted from Fischer in *Dict. Class. d'Hist. Nat.*, tom. p. 324

† *A. Soc Ent molog F nce* 1866 as quoted in *Journal of T d* by A. Murray 1868, p 135

thus grantu of S Chile—a splendid beetle be longing to the same family—has enormously developed mandible (fig 24) he is bold and pugnacious when threatened he faces round

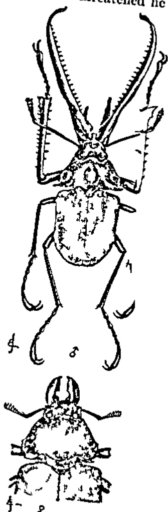


FIG 24 *Cl a gn thu gr nt ı* red ced Up- p r f gure male lo figure f m l

opens l ı

ie
t
~ ~ pa l ~ e

Sexual selection which implies the posses sion of considerable perceptive powers and of strong passions se ms to have been more ef fective with the lamellicorns than with any other family of beetles With some species the males are provided with weapons for fighting some live in pairs and show mutual affection many have the power of stridulating when excited many are furnished with the most extraordinary horns apparently for the sake of ornament and some which are diurnal in their habits are gorgeously coloured Lastly several of the largest beetles in the world be long to this family which was placed by Lin neus and Fabricius as the head of the Order ¹

Stridulating organs —Beetles belonging to many and widely distinct families possess these organs The sound thus produced can sometimes be heard at the distance of several feet or even yards ² but it is not comparable with that made by the Orthoptera. The ra p generally consists of a narrow slightly raised surface crossed by very fine parallel ribs, sometimes so fine as to cause iridescent col ours and having a very elegant appearance under the microscope In some cases as with Typhœus minute bristly or scale like prom inences with which the whole surrounding surface is covered in approximately parallel lines could be traced passing into the ribs of the rasp The transition takes place by their becoming confluent and straight and at the same time more prominent and smooth A hard ridge on an adjoining part of the body serves as the scraper for the rasp but this scraper in s me cases has been specially modi fied for the purpo e It is rapidly moved across the rasp or conver ely the rasp across the scraper

po
two ~ ı rasps (*r* fig 2) stand on the dors l surface of the fifth abdominal segment each rasp consisting of 126 to 140 fine ribs. These ribs are scraped against the posterior margins of the elytra a small portion of which projects beyond the general outline In many Crioceride and in *Clythra 4 punctata* (one of the Chrysomelid ı) and in some Tenebrion id ı &c the rasp is scate l on the dorsal apex of the al domen ı tl

W t l M l Cl f t l p 184
W ll t On(t Mus cal Curcul de
f l l M g f \ t H t L 1860 p 14
La d is, *Zeit h ft f ui sch ft Zoolog* B
1867 127
I g tly l bt d t M C B Cr t h f r
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l t
H be-
~ Clyth
l usly bser ed I m l l
l bted t Mr I W J f f ri t d
pec I y dd tl t y so M F D
ti l tl t *D m st* m tr ful t but h
st rel ed f tl pp tus Scolytu l s
l t h be n d st b d l y D Ch pm as tr l
l t tl *Ent logi t M thly M g ne* L
p 130

an th famil th rasps are placed on th les f the first bd minal gm t, and are scraped by ridg n tl f m a. In c t C rculi d.e and Car b dæ [7] th parts are compl t ly r sed po t n f r the asp re se ted th nf ri rface f th elytra, near th p ces, r al g tl r te margins,





F G. 25 \ cr ph rus (f m La d is) Th t rasps. Left ha d figure part of th ra.p highly m g fied

and th edg f tl abd minal gm ts erve as tl e scrapers. In I lob H rma i (f D tisci læ w t b tl) tro g dge ns parall l and to th tural margin f tl lytra, and is crossed by rib co rs in the



F G. 26 Hind l g f G ot pe stercor rius (from Land) Ra.p C f Femur t Tb t T rs

m l ll part b t becom g g ad ally fi t both nds, pe ally t th ppe d wh n tl insect is h ld d t in th air

t id l t g n i e s prod ced by tl e e trem h rny m rgin of tl e abd m n bei g sc aped gainst tl a.ps In gre t *number of* l ng h r ed beetles (Longicorni) th rg n are situ ted qu te tl rw se the rasp b i g n th m so-tho wh l is rubbed g inst tl e pro- th ax Lar do cou ted 238 very fine ribs on th rasp of *Cer nby l os*

Many lamell c r s l e the power of trid ulating, and the gan differ greatly n pos t Som peci trid l te ve y l udly so

nal segm nt In th ly all d *C prt l* ri an ces i ly n rrow fin ra.p r n al ng th utural ma gin f th elytra, th another l rt a.p near th basal uter margin but n som th C p ini th a.p se ted accord ing to Lecont [7] on the d al s rface of the abd m In O t s it is se t d on tl e pro- py d um d according to the same ent m l gi t, n some th r Dynast i on tl e un de s rface f th lyt Lastly W tring states th t n *Omalopl bru ica* the asp is placed n th p o- t rnum a d th scrap r n th m ta t rn m th p ts thu occ p g th u d fac f tl e body in tead f the uppe u face as the Lo gicorns

W th s see th t in tl diff rent colec pt famil th strid lati g gans are w le fully d rs fied po t n b t n t m h in tru ture W thin th sam fam ly some spe cies re p ded w th th o gans, nd tl rs are l t tut f them. Th d rs ty t l l g bl if w ppose tl t ri lly v beetl mad a shuffling or h ssing se by th rubbin tog tl f any hard and r gh p rt of th bod s, *wh h h ppe ed to be in* co tact d that from tl n se th p od ced b ing n som w y sef l the ro gl face wer grad ally d l ped nto regular tridu lating gans. Som beetl as th y m n w prod ce th int ti ally int nt n ally a sl ffling n ise w tho t po se any prope gan f th purpose Mr Wallace inf rms me th t the *E h rus lo g m* (a lam ll corn w th th ant r l gs wond

Schi dt tr nsl ted, *A al nd M gazine f Nat al History* L 1867 p 37

West g ha described (Krov *N t hist*

asps th lytra

[7] I m d bted t M Walsh f Ill s, f h g se t m t ts f m Leco t *Int od c tio to Ent ology* pp 101 143

fully elongated in the male) makes whilst moving a low hissing sound by the protrusion and contraction of the abdomen and when seized it produces a grating sound by rubbing its hind legs against the edge

... by rubbing the shagreened surface of the femur against the granulated margin of the corresponding elytron but I could not here detect any proper ...

... has written about this beetle it seems very doubtful whether it possesses any true rasp though it has the power of emitting a sound

From the analogy of the Orthoptera and Homoptera I expected to find the stridulating organs in the Coleoptera differing according to sex but Landois who has carefully examined several species observed no such difference nor did Westring nor did Mr G R Crotch in preparing the many specimens which he had the kindness to send me Any difference in these organs if slight would however be difficult to detect on account of their great variability Thus in the first pair of specimens of Necrophorus humator and of Pelobius which I examined the rasp was considerably larger in the male than in the female ...

... prominent in three males than in the same number of females in order therefore to *discover whether the sexes differed in their* power of stridulating my son Mr F Darwin collected fifty seven living specimens which he separated into two lots according as they made a greater or less noise when held in the same manner He then examined all these specimens and found that the males were very nearly in the same proportion to the females in both the lots Mr F Smith has kept alive numerous specimens of *Monoynchus pseudacori* (Curculionidæ) and is convinced that both sexes stridulate and apparently in an equal degree

Nevertheless the power of stridulating is certainly a sexual character in some few Coleoptera Mr Crotch discovered that the males alone of two species of Heliopathes (Tenebrionidæ) possess stridulating organs I examined five males of *H gibbus* and in all these there was a well-developed rasp partially divided into two on the dorsal surface of the terminal abdominal segment whilst in the same number of females there was not even a rudiment of the rasp the membrane of this segment being transparent and much thinner than in the male In *H cribratostriatus* the male has a similar rasp excepting that it is not partially divided into two portions, and the female is completely destitute of this organ the male in addition has on the ...

... resembling those on the abdominal rasp whether these ridges serve as an independent rasp or as a scraper for the abdominal rasp I could not decide the female exhibits no trace of this latter structure

Again in three species of the ...

... but the chief difference is that the whole upper surface of this segment when held in the proper light is seen to be clothed with hairs, which are absent or are represented by excessively fine down in the males It should be noticed that in all Coleoptera the effective part of the rasp is destitute of hairs In *O senegalensis* the difference between the sexes is more strongly marked and this is best seen when the proper abdominal segment is cleaned and viewed as a transparent object In the female the whole surface is covered with little separate crests bearing spines whilst in the male these crests *in proceeding towards the apex become more* and more confluent regular and naked so that three fourths of the segment is covered with extremely fine parallel ribs which are quite absent in the female In the females, however of all three species of Oryctes, a slight grating or stridulating sound is produced when the abdomen of a softened specimen is pushed backwards and forwards

In the case of the Heliopathes and Oryctes ...

... can t es-

cape by strikin th h llow t ms of trees in the Canary Islands, Messrs. W llaston and Crotch w re abl to disco th presence of beetles bel ging to the g n Acall s by th ir strid lati n. La tly th mal Ate h s trid latest ncoura the f mal n h r w k, and from distress wh he is rem ed [3] Som naturalists belie that beetles make th se to f ghten w y th e mies but I cann t think that q adruped b rd abl t d larg beetle, w uld b fri ht ed by so l ht sound Th beli f tl t tl tr d lat serv s as sexual call is pported by th fact th t death-ticks (1 b m t llat m) are w ll kn n to answ ach th t cki g and as found h n ted with a m l and on o oc-cas urrounded by sev ral males Finally it is prob ble th t th two sexes of many kinds f beetles w re at first bled to find each ther by th l gh l ffling no se produced by the rubbing t th of th adj n g hard parts f their bodies and that as tl ose m les or f mal s wl ch m de the g t t n se su ceeded be t n finding partn rs, rug iti on vari part of th r bod es w re grad ally d l ped by m ans of exual selc t on into true strid lati g gans.

M P d la Brul as q ted J rnal f I d, A. Murray L i, 1868, p 135

According to Mr D bleday th use is produced by th sect ra g tself ts l g as h gh as t ca d th triki g its th ra fi tna th l m l d P m l tria prod ces rath l ud so d by tr ki g l bd m g nst) hard b ta ce d th t th m l obed t t this call, soo tt d h d they pair

CHAPTER XI

INSECTS *Continued*—ORDER LEPIDOPTERA

BUTTERFLIES AND MOTHS

I ng points
ween the
e same species and between the distinct species of the same genus Nearly the whole of the following chapter will be devoted to this subject but I will first make a few remarks on one or two other points Several males may often be seen pursuing and crowding round the same female Their courtship appears to be a prolonged affair for I have frequently watched one or more males pirouetting round a female until I was tired without seeing the end of the courtship Mr A G Butler also informs me that he has several times watched a male courting a female for a full quarter of an hour but she pertinaciously refused him and at last settled on the ground and closed her wings so as to escape from his addresses

Although butterflies are weak and fragile creatures they are pugnacious and an emperor butterfly[1] has been captured with the tips of its wings broken from a conflict with another male Mr Collingwood in speaking of the frequent battles between the butterflies of Borneo says They whirl round each other with the greatest rapidity and appear to be incited by the greatest ferocity

The *Ageronia feronia* makes a noise like that produced by a toothed wheel passing under a spring catch and which can be heard at the distance of several yards I noticed this sound at Rio de Janeiro only when two of these butterflies were chasing each other in an irregular course so that it is probably made during the courtship of the sexes

Some moths also produce sounds for instance the males of *Theocopho a fo ca* On two occasions Mr F B h

a Cicada by an elastic membrane furnished with a muscle He quotes, also Guenee that Setina produces a sound like the ticking of a watch apparently by the aid of two large tympaniform vesicles, situated in the pectoral region and these are much more developed in the male than in the female Hence the sound producing or an in the Lepidoptera appear to stand in some relation with the sexual functions I have not alluded to the well known noi e ma le by the death s head phinx for it is generally heard soon after the moth has emer ed from its cocoon

Giard has always observed that the mu ky odour which is emitted by two species of phinx moths is p culiar to the males and in the higher cla es we shall meet with many instances of the males alone being odoriferous

Every one must have admired the extreme beauty of many butterflies and of some moths and it may be asked are their colours and diversified patterns the result of the direct action of the physical conditions to which these insects have been expo ed without any benefit being thus derived Or have successive variations been accumulated and determined as a protection or for ome unknown purpose or that one sex may be attract t t

s

s

es of the same genus Before attempting to answer the questions a body of facts must be given

With our beautiful English butterflies the admiral p acock and painted lady (Vanessæ) as well as many others the exes are alike This is also the case with th magn ficent Heliconidæ and most of the Danaidæ in the tropics But in certain othe tropical gro ps and in some of our English butt rflie as the purple emperor o ang tip &c (*Apatu a iris* and *Anthocharis ca dam*) the sex s diff r either greatly or sl ghtly in colou No lan

[1] *Apat r* ri The *E t mol g t We kly Intell gence* 1859 p 139 F r the B nean b tterfl s, s e C C ll gwood *R mbl f a N t r l t* 1868 p 183

See n y *J r l f R h* 1845 p 33 M D ubled y l as l t ted (*P oc E t Soc* M rch 3 1845 p 123) a pecul r m nb sa t th ba f the fro t w gs, h ch prob bly co r ect l th the prod ct n f th sou d l r th ca f Th cophora, se *Zool g cal R cord* 1869 p 401 F M B char r Wh t b rs t s, th *Scott h N t al st* July 18 2 p 214

[1] Th *Scott h Nat l t* J ly 18 p 213 *Zool g l l* 1863 p 347

guage suffices to d scrib th spl nd u of the males of som trop cal pecies. E n w th n th sam g nus w lt n find peci prese t ing extraordinary diff re ces b tween the sexes, hilst oth s h tl r sex closely I Tl n th So th Am can g nu Ep

r tins

I: tw l e pecies, tl tw sex f wh h

species the males rank am g t the mo t bril liant f all b tt rfl s, and d ff so gre tly from th compar ti ly plai f m l tl at they w re f rm rly placed d t ct e ra. Th females f th se n pec resembl each th in th ir g al t pe f col t and tl ey lik wise re mble b th sex f th species se e al allied g ra f d n n ou parts f th w ld H ce w m f that these nin peci s, and probabl ll th th rs f th g s, are lesce ded from an ancestral f rm wl ch was colo ed n n arly the sam mann I th tenth spec th fe m l still retains th sam g al l ring, b t th mal resembles h so th t l col ured m l l ss g d ar d co t asted mann tha the males f the p n peci s. In tl l th an l t llth pec s, th f mal l p rt from tl al type f th y are gaily deco ted lmost lik th mal s, b t n som what less d gre H ce in tl se t I t le peci th b ght col rs f th m les seem to ha bee tra f rred t th f m l wl l t in tl tenth pec tl mal l as th re tained reco red th pl col rs f the fe mal as ll as f th par t f m of th g us. Th se es in these tl ree case ha th bee rendered arly alik th gh in an p posite man In tl lled g Eub gis, both se f som f tl peci are plai colo red and early al k l lst w th th gre te mbe tl mal re deco ted with bea tif l m tall tint d rsified mann and diff m ch from tl f mal Th fe male thro gh t tl g retain th sam g e l t l f col uri g, so th t th y resem ble anoth m l m l sely than tl y rese l le the w mal

In the genus Pap lio, all the species of the Æneas gro p are remarkable for the r conspic u us and strongly co trasted col u s, an l tl y ill st ate tl frequ t tend ncy to grad t on t m i t f diff re ce b twee tl sex s.

th species re embl each ther an l re ue t t te f ch colo rs, et in ce tain spec s,

Engl h bl b tt fl es f th gen Ly æna ll trate the ar l ff rences in col ur be tween tl se s, alm t as w ll tho gh t i so trik g mann as tl e bove ex ti g n ra. In *Ly* r *g tis* b tl se s l e w gs f a brown col u b rd ed w tl mall ocell ted ang pots, and re tl u like In *L ag* tl wings f th m l are f fin blue b rd red w th black, wl l t tl se of th femal are brown w tl m lar bord clos ly sem bling th w gs f *L g t* Lastly n *L ar* botl se s re f bl col u and ar ry lik th gh th f mal th edges of tl e wings are th du ki with th black pot plain and n a bri ht bl e Ind n spec botl sex are still m re alik

I h gi n tl f reg ing d tails in rd t sl w n th first place that wh n th se f butt rfl d ff tl e mal as g n al rul th m re b tiful and d parts m re fro th us al t pe f col g f the gro p t wh i the species bel g H nce n m t gro ps tl f mal f th se ral pec res mbl el th m h m re closely than d tl mal In som ases, l w to wh h I hall h re ft all d th f m les are col d m re spl n d dly than tl males. In th seco d pla e th se d tails ha been gi n t b g clea ly bef re tl and th t th n th sam g n th two se freq ntly prese t ry g ad

See lso M B tes pape P oc. *Ent. Soc f Philadelph a*, 1865, p 2 6 Also M W llace th same subject, regard t Diad ma, *Transactions E t mological Society* Lond n, 1869 p 2 8.

tion from no difference in colour to so great a difference that it was long before the two were placed by entomologists in the same genus In the third place we have seen that when the sexes nearly resemble each other this appears due either to the male having transferred his colours to the female or to the male having retained or perhaps recovered the primordial colours of the group It also deserves notice that in those groups in which the sexes differ the females usually somewhat resemble the males so that when the m l beautiful to ales almost auty From t e amount of u ierence between the sexes and from the prevalence of the same general type of coloration throughout the whole of the same group we may conclude that the causes have generally been the same which have determined the brilliant colouring of the males alone of some species and of both sexes of other species

As so many gorgeous butterflies inhabit the tropics it has often been supposed that they owe their colours to the great heat and moisture of these zones but Mr Bates[6] has shown by the comparison of various closely allied groups of insects from the temperate and tropical regions that this view cannot be maintained and the evidence becomes conclusive when brilliantly coloured males and plain coloured females of the same species inhabit the same district feed on the same food and follow exactly the same habits of life Even when the sexes resemble each other we can hardly believe that their brilliant and beautifully arranged colours are the purposeless result of the nature of the tissues and of the action of the surrounding conditions

With animals of all kinds whenever colour has been modified for some special purpose this has been as far as we can judge either for direct or indirect protection or as an attraction between the sexes With many species of butterflies the upper surfaces of the wing are obscure and this in all probability leads to their escaping observation and danger But butterflies would be particularly liable to be attacked by their enemies when at rest and most kinds whilst resting raise their wings vertically over their backs so that the lower surface alone is exposed to view Hence it is this side which is often coloured so as to imitate the objects on which these insects commonly rest Dr Rössler I believe first noticed the similarity of the closed win of certain Vanessæ and other butterflies to the bark of trees Many analogous and striking facts could be given The most interesting one is that recorded by Mr Wallace[7] of a common Indian and Sumatran butterfly (Kallima) which disappears like magic when it settles on a bush for it hides its head and antennæ between its closed wings which in form colour and veining cannot be distinguished from a withered leaf with its footstalk In some other cases the lower surfaces of the wings are brilliantly coloured and yet are protective thus in *Thecla rubi* the wings when closed are of an emerald green and resemble the young leaves of the bramble on which i

i – colour on their upper surface the lower surface is closely similar or identical in both sexes and serves as a protection[8]

Although the obscure tints both of the upper and under sides of many butterflies no doubt serve to conceal them yet we cannot extend this view to the brilliant and conspicuous colours on the upper surface of such species as our admiral and peacock Vanessæ our white cabbage butterflies (Pieris) or the great swallow tail Papilio which haunts the open fens—f r these butterflies are thus rendered visible to every living creature In these species both sexes are alike but in the common brimstone butterfly (*Gonepteryx rhamni*) the male is of an intense yellow whilst the female is much paler and in the orange tip (*Anthocharis cardamines*) the males alone have their wings tipped with bright orange Both the males and females in these cases are conspicuous and it is not credible that their difference in colour should stand in any relation to ordinary protection Prof Weismann remarks[9] that the female of one of the Lycænæ expands h r br n wings when she settles on the ground and is then almost invisible the male on the other hand as if aware of the danger incurred from the bright blu of the upper surface of his wings rests with them closed and this shows that the blue colou cannot be in any way protective Nevertheless it is probable that conspicuous colours are indirectly beneficial to

[6] *The N t ral t n the Amazons* v I. i 1863 p 19

ee tl t rest g t l th B *im nster Re cw* J ly 1867 p 10 A od t f th K llm u g l y M W ll ce *H dr k* Sci nc *Gossip* Sept n l r 186 p 196

M C F A tu Ap l 1871 p 459

L fl s der I ol g f d t lbild g 18 L p 58

man species, as a warning th t th y are u palatabl F in certain th cases, b ty has bee gained thro gh th mitat f tl er bea tiful pec es, h ch nhab t the same d strict and an immunity from attack by being in som w y ff si to th ir e m es b t th ha e to acco t f the be ty f the im tated pec es.

As Mr Walsh has rem ked to m th

ours of th pare t speci s f th genus f r both se es f f fi e d ly-d trib ted species are coloured in arly th same mann r As in several previ cases, we may here nf r that t th males f 4 th d m ne d genus which ha departed from th us l t pe f th gen s. In th Anth from Cal

som tl r respects. I an allied Indian f rm, th Iph as gla cippe th ang t p are fully d loped in both se s. In this Iphias, a

up th d rface resembles th fl h l

pped th bright ang f th sam purpose, especially wh n this charact is confined to th mal s.

Most m ths r t m t nl ss dur g tl hole gre t part f th day w th tl ings d pressed nd th wh l uppe urface shaded and col red in an admirabl mann as M Wallace l as m ked f scap g d tect n. Th fro t gs f th Bombycidæ, ben t rest, g rally lap and conceal tl hind g so that th latt m ght be brightly col ed with t m ch risk and th y are i fact ft thus coloured D ring fl ght, m ths ld often be bl to escape from th e-mies rth less, as th l d ing re th full posed t w th bright col rs must gen ally ha bee acquired t som l ttl risk. B t th f llow g fact h w h w ti s

w ght t be in drawing conclus ons n th s head The comm n y ll w unde wings (Triphæna) ft n fly bout during tl day o early g and are then consp cu us from the col f the r hind w gs. It w ld naturally be tl ought th t this would b source f dan g r b t Mr J Jen e W r bel s tl at t actually serves th m as a m ans f esc pe for

rous pecime f *Triphæna p ba*, which was instantly p rsued by a rob n but th b rd s ttenti b ing ca ght by th col red wings th m tl was t captured unt l aft bo t fifty tt mpts, and mall port s of the w gs w re repe tedly broke ff H tried tl sam xperime t, in th pen r w th swal low and *T fimbria*, b t tl larg siz of this m tl prob bly te f red witl ts capt re[11] W thus emi ded f a tat m nt made by M W llace[12] nam ly that n th B azilian f re ts and Malay sl ds, many comm n and highly-deco ted b tt rfl e are w ak fly rs, th gh furnished w th a l oad e panse f wi g and th y are fte capt ed w th p rced and brok n w gs, as f tl e had been seized by b rd f m wl ch tl ey had escaped if tl wings had bee m ch malle in propor ti t th body t se m probabl that th insect uld mo f eq ntly hav been truck p rced in a v tal part, and thus the in creased expanse f th wings may ha be n indir tly be eficial

Display —The bright col urs f many butt fl es and of som m ths are specially arranged f display so that th y m y be read ily see During th ght col rs re n t vi ble and th re can be n d ubt that th noct rnal m ths, tak n as body are m ch l ss gaily decorated than b tt rfl es, ll f whi h are d rnal in th hab ts B t th m th f certain famili s, h as th Zygænidæ, se al Sphingidæ, U an dæ, some Arctiidæ and S turniidæ, fly bo t during th d y arly ning, and many f th se re xtrem ly b tif l, b ing far bright col ured th n th stri tly octurnal ki ds. A f w cepti nal cases, h w f bright-col ured noct rnal speci ha been reco ded

See the terrati g bserv tions by T W Wood, the Student, Sept., 1868, p. 81

M Wallace *Hardwick Science Gossip*, September 186 p. 193

See also, this bject, Mr W ir paper in *T nsact ons Entomological Society* 1869 p. 23

Westminster Review J ly 1867 p 16

F nsta ce Lithosia but Prof Westwood (*M dern Clas f Insects* ol ii., p 390) seem ur

There is evidence of another kind in regard to display Butterflies as before remarked elevate their wings when at rest but whilst basking in the sunshine often alternately raise and depress them thus exposing both surfaces to full view and although the lower surface is often coloured in an obscure manner as a protection yet in many species it is as highly decorated as the upper surface and sometimes in a very different manner In some tropical species the lower surface is even more brilliantly coloured than the upper [15] In the English fritillaries (Argynnis) the lower surface alone is ornamented with shining silver Nevertheless as a general rule the upper surface which is probably more fully exposed is coloured more brightly and diversely than the lower Hence the lower surface generally affords to entomologists the more useful character for detecting the affinities of the various species Fritz Müller informs me that three species of Castnia are found near his house in S Brazil of two of them the hind wings are obscure and are always covered by the front win s when these butterflies are at rest but the third species has black hind wings beautifully spotted with red and white and these are fully expanded and displayed whenever the butterfly rests Other such cases could be added

If we now turn to the enormous group of moths which as I hear from Mr Stainton do not habitually expose the under surface of their wings to full view we find this side very rarely coloured with a brightness greater than or even equal to that of the upper side Some exceptions to the rule either real or apparent must be noticed as the case of Hypopyra [1] Mr Trimen informs me that in Guenee s great work three moths are figured in which the under surface is much the more brilliant For instance in the Australian Gastrophora the upper surface of the fore wing is pale greyish ochreous while the lower surface is magnificently ornamented by an ocellus of cobalt blue placed in the midst of a black mark surrounded by orange yellow and this by bluish white But the habits of these three moths are unknown so that no explanation can be given of their unusual style of colouring Mr Trimen also informs me that the lower surface of the wings in certain other Geometræ[17] and quadrifid Noctuæ are either more variegated or more brightly coloured than the upper surface but some of these species have the habit of holding their wings quite erect over their backs, retaining them in this position for a con ider able time and thus exposing the under surface to view Other species when settled on the ground or herbage now and then suddenly and slightly lift up their wings Hence the lower surface of the wings being brighter than the upper surface in certain moths is not so anomalous as it at first appear The Saturniidæ include some of the most beautiful of all moths, their wings being decorated as in our Briti h emperor moth with fine ocelli and Mr T W Wood[18] observes that they resemble butterflies in some of their movements for instance in

the case with many brilliant butterflies Tle male however of one American moth tle *Saturnia io* is described as having its fore wings deep yellow curiously marked with purplish red spots whilst the wings of the fe

low tints or nearly white In several species the males are much darker than the females [19]

p s d t th s cas On th el ti e colours f d urn l nd n tu nal Lep d pter e *ibid* pp 333 d 392 also Ha ris *T atise n th Ins cts of New E g land* 1842 p 315

[15] h d ff en es b tween the upp r nd lo er surfaces f the w gs of se er l pec es f P p l o m y b een in th b tif l plat s to M W ll Mem th P p l dæ f th M l y n Re gion in *Tr nsactions of th L nne Society* l. xxv part i 1865

[16] See Mr W rmald on this m th *P oc ed g f the Entomological Society* March 2, 1868

[17] See lso an ccou t f th S Am ican g nus Erate na (n f the G m t æ) *T nsactio E t Soc* n w r l pls v nd

[18] *P oc Ent Soc of Londo* July 6 1868 p

[19] Ha s, *T eatise &c* ed ted by Fl t 1862, p

f rm m th t w h r h h bel s n

d M Sta t bse ed th t this L tter m th as r j cted w th utt disgust by a wh le brood f y g turk ys, wh ch re fond f ting ther

and these belon, to groups which generall fly about during the afternoon. On th other hand in ma. enera, as Mr Stainton inf rms me, the males have the hind wings whiter than those of the female—of which fact Agrotis exclamationis o ers good instance. In the ghost-moth (H pia us h mul) th difference is more strongly marked th males bein .ite, and th f males llow with dark r markings.[11] It is probable that in these cases the males are thus rend red more conspicuous, and more asly seen by the f males whilst flying about in the dusk.

From the several foregoing facts t is impossible to admit that th brilliant colours of b tterfies, and of som f w moths, have commonl been acquired for the sake of protection. W have seen that their colours and elegant patterns are arranged and exhib ted as if for display Hence I am led to beli .hat the females prefer or are most .cited b the more brilliant males for on any oth supposition the males would, as far as w can see be ornamented to no purpose. W kn w that ants and certain lamellicorn beetles re capable of feeling an attachment f ach oth and that ants recognise their f llow after an interval of se eral months. H nce th re is no ab tract improbability in the Lepidoptera, which probabl stand nearly quit as high in the scale as these insects, ha ing suffici t m ntal capac ty to admire bright colours. Th y certainly discover flow rs b colour Th hummin -bird sphinx may often be seen to swoop d n from distance n a bunch of flow rs in th midst of green foliage and I ha been assured b two persons abroad, that these moths repeatedly visit flowers painted n th walls of a room, and vainly ndea ur to insert their proboscis into them. Fritz Mülle informs m that se eral kinds of butterflies in S. Brazil shew an unmistakable preference for certain colours er others h observed that they ry oft n visited the brilliant red flowers of fi or six

moths, so that if the Cycnia was commonly mistake by British birds for the palosoma, t would escape being devoured, nd ts hite deceptive colour would thus be highly beneficial.

[11] It is remarkable, that in the .etland Islands the male of this moth, instead of diffen g idely from the female, frequently resembles her closely in colour (see Mr MacLachlan, *Transactions Entomological Society*, vol. ii. 1866, p. 459). Mr G Fraser suggests ature, April, 18 1 p. 489) that t the season of the year hen the ghost moth ppears in these northern islands th hiteness of the males ould not be needed to render them visible to th females in the t ilight night.

genera of plants, but n er the white or yellow flow ring pecies of the sam and oth r genera, growing in th same garden and I ha e received oth r accounts to the same effect. As I hear from Mr Doubled y th comm n whit b .fly oft n fl es d wn to a b t of paper on

or th ...

flies in the Mala Archipelago, tates that a dead pecim n pinned upo a con p cuous twig will often arrest an insect of th sam pecies in ts headlon, fl ght, and b ing it d wn with in eas reach of the n t, pecially if it be of the opposite sex.

Th courtship of butt rflies is, as bef re remarked, a prolonged affair The males sometimes fi ht t eth in ri alry and many ma be seen pursuing o crowding round the same f male. Unless, then, the f males pref n male to an th th pairing must be left t m ... nce nd th does not ppear probable.

males, ...

rend red brighter by d grees, and will ha been transmitted to both sexes o to one sex according t th law of inh ritance which has prevailed. Th process of se ual selection w ll ha e been m ch facilitated, if th con lus n can be tru ted, arri ed t from ari us kind of id nce in the ppl m nt to th ninth chapt namely that th males of many Lepid ptera, l ast in the imago tat greatly xceed th f males in numbe

Som facts, h we are opposed to the beli f that f male butterfl es pref th more beautiful males thus, as I hav been a sured by se ral collect rs, fresh f mal may freq ently be seen paired with batt red faded, dingy males b t this is circumstance which could hardly fail often to f llow from th males merging from their cocoons arli r than the f males. W th moths of th family of th Bomb cidæ, th sexes pair immediat ly a te assuming th imago stat f r they can not feed, win to the rudim ntary conditio f their m ths. Th females, as several entomologists ha remarked to m he in an almost torpid tat and ppear n t to nce th l ast choice in regard to their partners. This is th case with th common silk moth (B mori) as I ha been told by som continental and English breed rs. D Wallace who has had

Rambles of Naturalist in the Chinese Seas, 1868, p. 182.

great experience in breeding *Bombyx cynthia* is convinced that the females evince no choice or preference He has kept above 500 of these moths together and has often found the most vigorous females mated with stunted males The reverse appears to occur seldom for as he believes the more vigorous males pass over the weakly females and are attracted by those endowed with most vitality Nevertheless the Bombycidæ though obscurely coloured are often beautiful to our eyes from their elegant and mottled shades

I have as yet only referred to the species in which the males are brighter coloured than the females and I have attributed their beauty to the females for many generations having chosen and paired with the more attractive males But converse cases occur though rarely in which the females are more brilliant than the males and here as I believe the males have selected the more beautiful females and have thus slowly added to their beauty We do not know why in various classes of e males of e

as seems to be the general rule in the animal kingdom but if contrary to what generally occurs with the Lepidoptera the females were much more numerous than the males the latter would be likely to pick out the more beautiful females Mr Butler shewed me several species of Callidryas in the British Museum in some of which the females equalled and in others greatly surpassed the males in beauty for the females alone have the borders of their wings suffused with crimson and orange and spotted with black The plainer males of these species closely resemble each other shewing that here the females have been modified whereas in those cases where the males are the more ornate it is these which have been modified the females remaining closely alike

In England we have some analogous cases though not so marked The females alone of two species of *Thecla* have a bright purple or orange patch on their fore wings In Hipparchia the sexes do not differ much but it is the female of *H janira* which has a conspicuous light brown patch on her wings and the females of some of the other species are brighter coloured than their males Again the females of *Colias edusa* and *hyale* have orange or yellow spots on the black marginal border represented in the males only by thin streaks and in Pieris it is the females which are ornamented with black spots on the fore-wings, and these are only partially present in the males Now the males of many butterflies are known to support the females during their marriage flight but in the species just named it is the females which support the males so that th play is re throughout monly take e active share in wooing and their beauty seems to have been increased by the females having accepted the more attractive individuals but with these butterflies, the females take the more active part in the final marriage ceremony so that we may suppose that they likewise do so in the wooing and in this case we can understand how it is that they have been rendered the more beautiful Mr Meldola from whom the foregoing statements have been taken says in conclusion "Though I am not convinced of the action of sexual selection in producing the colours of insects it cannot be denied that these facts are strikingly corroborative of Mr Darwin's views"

As sexual selection primarily depends on variability a few words must be added on this subject In respect to colour there is no difficulty for any number of highly variable Lepidoptera could be named One good instance will suffice Mr Bates shewed me a whole series of specimens of *Papilio sesostris* and *P childrenæ* in the latter the males varied much in the extent of the beautifully enamelled green patch on the fore wings and in the size of the white mark and of the splendid crimson stripe on the hind wing

ess beautiful than of *P childrenæ* and it likewise varies a little in the size of the green patch on the fore wing and in the occasional appearance of the small crimson stripe on the hind wings borrowed as it would seem from its own female fo the females of this and of m e

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ot *childrenæ* there was but a small interval and it was evident that as far as mere variability is concerned there would

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be no difficulty in perman tly increasin th bea ty of eith speci by means f selection. The ariabilit is here almost confined to the male se b t Mr Wallace and M B tes ha shewn that the f males f som pecies are extrem ly ariabl th mal s being nearly constant. In f ture ch pt r I shall ha oc casio to sh w that th be tiful lik spots, ocelli, f und n th wings f many Lepid pt ra, are min tly ariabl I may here add that these ocelli ff r a difficulty n the theory f se ual selecti f th gh p pearing t us so rnam ntal, th are n prese t in sex and abse t in th th r n do th y diff much in th tw se es. This fact is t present inexplicab b t if t should h reaft be f und that th f rmati of an ocellus is d to some chang in th i

alone.

On th wh le, altho gh many seri us objec tions may be urged, t seems probabl that most of th brilliantl col ured species f Lepid pt ra w th ir col urs t sexual selec tion, excepting in certain cases, prese tly t be m tio d in which consp cu us colours ha been gained thro h mimicry as protecti From the ard f th mal thro gho t th animal kingd m, h is g n rall willing to ac cept any f mal and t is th f mal which usually rts cho ce H ce if sexual selec tio has been ffici nt w th th Lep d pt ra, th mal wh th se es diff ght t be the more brilliantl coloured and this un doubtedl is th case When both sexes are brilliantl coloured and resembl ach th the charact rs acquired b th males ppear t ha ber transmitted to both. W are led to this conclusio b cases, w thin th sam genus, of gradati from an extraordinary amount of diff rence t id tity in colo be t ee th t se es.

B t t ma be asked wh th th diff rence colour bet een th se es may n t be ac

m comm nly baskin ... latt r haunting gloom f re ts. It is th ref re possibl that diff rent conditi ns of lif mat ha acted directly on the tw se s but this is n t probable as in th adult stat th are exposed to diff rent conditions d rin a ry sh rt period and th larvæ of both are ex posed t th same co diti ns. M Wallace beli es that th diff rence between th sexes is d n t so m ch t th males h g been modified as t th f mal having in all r al most all cases acquired dull col urs f th sak f protecti n. It seems to me on th con trary far m re probabl th t t is the males which ha been chi fl modified through sexual selecti n, th f males having been com parati ly littl chan ed. W can thus und tand how t is that th females f allied spe cies rally resembl n an th so much

th y bel ng. Th y ha e, how er almo t alw y been som what modified by the trans f t th m f som f th successi e aria ti ns, through th accumulation of which th males w re rend red be tif l. B t I do n t wish to d ny that the f males alon f som species ma ha been pecially modified f protection. In m t cases the males and f males of distinct species will ha been xposed during th ir prol nged larv l tate to diff rent conditi ns, and ma ha been th affected though with th males any sligl t chang of colour thus caused will gen rally ha been masked by th brill ant tints gained thro gh sexual selection. Wh n w tre t of birds, I shall ha t discuss th wh l q esti n, as to h w far th diff rences in col ur between th sexes are d to th males having been modi fied thro gh sexual selecti n f ornam ntal purposes, to th f males havi been modi fied thro gh natural selecti n f the sak f protection, so that I will h re say b t littl n th subject.

In all th cases in which th more common f rm of equal inh ritance by both sexes has

Wallace the P pilio idæ of the Malaya Region, T nsact L nn. oc ol 1865 pp. 8, 36 A trik g case of rare variety trictly in ermediate bet ee t other w ll-marked f male arieties, g by Mr Wallace. See also M B es, I oc Entomolog Soc N 19 1866, p. xl. M Bates as so kind as t lay th bject be fore the Entomological Society and I have received nswers to this ffect from several ntomologists.

H. W B tes, Th Naturalist the Amazons, vol. ii., 1863, p. 228. A. R. Wallace, in T ansact n Li nea Society 1 xxv 1865 p 10

On this hole ubject see The Variatio of A i mals and Plants nder Domestication, 1868, ol. ii., chap. xxiii.

great experience in breeding *Bombyx cynthia* is convinced that the females evince no choice or preference He has kept above 300 of these moths together and has often found the most

weakly females and are attracted by those endowed with most vitality Nevertheless the Bombycidæ though obscurely coloured are often beautiful to our eyes from their elegant and mottled shades

I have as yet only referred to the species in which the males are brighter coloured than the females and I have attributed their beauty to the females for many generations having chosen and paired with the more attractive males But converse cases occur though rarely in which the females are more brilliant than the males and here as I believe the males have selected the more beautiful females and have thus slowly added to their beauty We do not know why in various classes of animals the males of some few species have selected the more beautiful females instead of having gladly accepted any female as seems to be the general rule in the animal kingdom but if contrary to what generally occurs with the Lepidoptera the females were much more numerous than the males the latter would be likely to pick out the more beautiful females Mr Butler shewed me several species of Callidryas in the British Museum in some of which the females equalled and in others greatly surpassed the males in beauty for the females alone have the borders of their wings suffused with crimson and orange and spotted with black The plainer males of these species closely resemble each other shewing that here the females have been modified whereas in those cases where the males are the more ornate it is these which have been modified the females remaining closely alike

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that the part which the two sexes play is reversed as is their relative beauty Throughout the animal kingdom the males commonly take the more active share in wooing and their beauty seems to have been increased by the females having accepted the more attractive individuals but with these butterflies, the females take the more active part in the final marriage ceremony so that we may suppose that they likewise do so in the wooing and in this case we can understand how it is that they have been rendered the more beautiful Mr Meldola from whom the foregoing statements have been taken says in conclusion "Though I am not convinced of the action of sexual selection in producing the colours of insects, it cannot be denied that these facts are strikingly corroborative of Mr Darwin's views"[23]

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son stripe on the hind wings borrowed as would seem from its own female for the females of this and of many other species in the Æneas group possess this crimson stripe Hence between the brightest specimens of *P sesostris* and the dullest of *P childrenæ* there was but a small interval and it was evident that as far as mere variability is concerned there would

1 97 1871 p 08 Mr Meldol

amply confirmed[30] especially by Mr. Belt. Hence Mr. Bates inferred that the butterflies which imitate the protected species have acquired their present marvellously deceptive appearance through variation and natural selection, in order to be mistaken for the protected kinds, and thus to escape being devoured. No explanation is here attempted of the brilliant colours of the imitated, but only of the imitating butterflies. We must account f

B tes pape milar and eq ally t inking facts h e bee bserved by Mr W llace in th Malayan regn by Mr T ime in South Africa, and by Mr Riley in the United States.[31]

As some writers have felt much difficulty in understanding how the first steps in the process of mimicry could have been effected through natural selection, it may be well to remark that the process probably commenced long ago between forms not widely dissimilar in colour. In this case even a slight variation would be beneficial, if it rendered the one species more like the other; and afterwards the imitated species might be modified to an extreme degree through sexual selection or other means, and if the changes were gradual, the imitators might easily be led along the same track, until they differed to an equally extreme degree from their original condition; and they would thus ultimately assume an

many species of Lepidoptera are liable to considerable and abrupt variations in colour. A few instances have been given in this chapter; and many more may be found in the papers of Mr. Bates and Mr. Wallace.

With several species the sexes are alike, and imitate the two sexes of another species. But Mr. Trimen gives, in the paper already referred to, three cases in which the sexes of the imitated form differ from each other in colour, and the sexes of the imitating form differ in a like manner. Several cases have also been recorded where the females alone imitate brilliantly-coloured and protected species, the males retaining the normal aspect of their immediate congeners. It is here obvious that the successive variations by which the female has been modified have been transmitted to her alone. It is, however, probable that some of the many successive variations would have

served which were from the first strictly limited in their transmission to the female sex. We have a partial illustration of these remarks in a statement by Mr. Belt,[32] that the males of some of the *Leptalides, which imitate protected species,* still retain in a concealed manner some of their original characters. Thus in the *males* the upper half of the lower wing is of a pure white, whilst all the rest of the wings is barred and spotted with black, red and yellow, like the species they mimic. The females have not this white patch, and the males usually conceal it by covering it with the upper wing, so that I cannot imagine its being of any other use to them than as an attraction in courtship, when they exhibit it to the females,

Bright Colours of Caterpillars.—Whilst reflecting on the beauty of many butterflies, it occurred to me that some caterpillars were splendidly coloured; and as sexual selection could not possibly have here acted, it appeared rash to attribute the beauty of the mature insect to this agency, unless the bright colours of their larvæ could be somehow explained. In the first place, it may be observed that the colours of caterpillars do not stand in any close correlation with those of the mature insect. Secondly, their bright colours do not serve in any ordinary manner as a protection. Mr. Bates informs me, as an instance of this, that the most conspicuous caterpillar which he ever beheld (that of a Sphinx) lived on the large green leaves of a tree on the open llanos of South America; it was about four inches in length, transversely banded with black and yellow, and with its head, legs, and tail of a bright red. Hence it caught the eye of any one who passed by at the distance of many yards, and no doubt that of every passing bird.

B tes theory

[32] *The Naturalist in Nicaragua,* 1874, p. 385.

prevailed the election of bright-coloured males would tend to make the females bright coloured and the selection of dull-coloured females would tend to make the males dull If both processes were carried on simultaneously they would tend to counteract each other and the final result would depend on whether a greater number of females from being well protected by obscure colours or a greater number of males by being brightly-coloured and thus finding partners succeeded in leaving more numerous offspring

In order to account for the frequent transmission of characters to one sex alone Mr Wallace expresses his belief that the more common form of equal inheritance by both sexes can be changed through natural selection into inheritance by one sex alone but in favour of this view I can discover no evidence We know from what occurs under domestication that new characters often appear which from the first are transmitted to one sex alone and by the selection of such variations there would not be the slightest difficulty in giving bright colours to the males alone and at the same time or subsequently dull colours to the females alone In this manner the females of some butterflies and moths have it is probable been rendered inconspicuous for the sake of protection and widely different from their males

I am however unwilling without distinct evidence to admit that two complex processes of selection each requiring the transference of new characters to one sex alone have been carried on with a multitude of species —that the males have been rendered more brilliant by beating their rivals and the females more dull coloured by having escaped from their enemies The male for instance of the common brimstone butterfly (Gonepteryx) is of a far more intense yellow than the female though she is equally conspicuous and it does not seem probable that she specially acquired her pale tints as a protection though it is probable that the male acquired his bright colours as a sexual attraction The female of *Anthocharis cardamines* does not possess the beautiful orange wing tips of the male consequently she closely resembles the white butterflies (Pieri) so common in our gardens but we have no evidence that this resemblance is beneficial to her As, on the other hand she resembles both sexes of several other species of the genus inhabiting various quarters of the world it is probable that she has simply retained to a large extent her primordial colours.

Finally as we have seen various considerations lead to the conclusion that with the greater number of brilliantly-coloured Lepidoptera it is the male which has been chiefly modified through sexual selection the amount of difference between the sexes mostly depending on the form of inheritance which has prevailed Inheritance is governed by so many unknown laws or conditions that it seems to

ess of variation are necessarily transmitted

at all between the sexes of allied species These cases of gradation it may be added are much too common to favour the supposition that we here see females actually undergoing the process of transition and losing their brightness for the sake of protection for we have every reason to conclude that at any one time the greater number of species are in a fixed condition

Mimicry —This principle was first made clear in an admirable paper by Mr Bates,[*] who thus threw a flood of light on many obscure problems It had previously been observed that certain butterflies in S America belonging to quite distinct families, resembled

As the Heliconidae are coloured in their usual manner whilst the others depart from the

cies are comparatively rare whilst the imitated abound and that the two sets live
of the Heli

concluded that they must be protected from the attacks of enemies by some secretion or odour and this conclusion has now been

Th I n tio f A mal nd Plants der Domtcat n, l ch p p. 17

T nsact. Linn. Soc. I iii. 1862, p 495

admits th ag ncy f selecti n of any kind ll after ading th bo e disc ss on, d s- p t th t th se m s al in trum nt h been acq ired thro gl sexu l selection. In f ur th Orde th m mb rs f n se m re r l ll se s, are p ded th

protect n So t s in some n tance wh n both a e b l tly-col ured f they thu m t t protected species, or resemble su round g object u h as fl we s r th y gi e ot ce t th r n m e that they are unpal tabl In oth r cases in wh h th se s esembl each th and are b th b ll ant, especially wl n the col rs re a ra ged fo d pl y we may co clud th t tl y ha e been gained b the mal se as n att act n and h be n trans- fer ed t the femal We ar more pec lly led t th conclu when r the same type

a se et d rful d ty f the mea f pro- d ici g so d possessed b the mal al n

whilst others diff l ghtly o n t at all w th inte med te g adat n co nectin these e tr me tat s.

I tl sam mann as bri ht col urs l a ft n been part ally t nsf rred from th mal to th f males, so t has been with the xt r

From th reasons ass gned in th last cl p- t t p b bl that th gre t l rn po sessed by th m les f many lam ll corn and som th beetles ha e been acquired as rna- m ts. From th mall ize f insects, w re apt to nd rval th ppe ance If w co ld magine m l Chalcosoma (fig 16) w th ts polished bro zed coat f mail d ts

and Orth pte ha g n rally been t ans- f rred in a rud m ntary e n m a n ly p rfect co dit to the f mal yet n t f fi i ntl pe fect to b f any use It is lso an int t g fact, as b ring n se al sel ti n th t th st d lating o gans of certain m l Orth pt re n t f lly de l ped unt l th last m lt and that th colo f ce tain mal d g fli re t f lly d loped u til som l ttl time aft tl r em gence from the p pal tat and wl th y are ready to b eed

Tl col ring f insects is compl and obscure bject Wh th m l d ff l ghtly from th f m l and n th are brill tly col ured t is probabl that th se es h aried in l ghtly diff re t mann and th t th ri ti ns ha bee t an mitted b ach se t th sam w th t any b fit l thus accruing Wl th mal b ll tly col red and d ff co p cu ly from th f mal as th som d g nfl and many b tt fl es, t prob bl th t h hi col rs to se al select whilst th f mal has retai ed prim rd al ry anci t typ f col rin l ghtl modified by tl g es bef re xpla ed B t in som ase th f m l has ppare tl bee mad bscure by tio t ansm tted t h al as m f d rect protect and t is alm t ce tai th t sl ha som tim bee mad brilliant, so as to m tate th protected pec es inl ab ting th sam distri t. Wh th se resembl ach th and both are bsc ly col red th re is d bt that th y h bee a m litt d l case so coloured f th sak f

Sexu l select mplies th t the m re t tracti d d l re p f rred by th p- posit se and as with sects wh n the d ff t is th mal which, with som are except ns, th m re rnamented and d parts m re from th typ to which th peci b l g —and as t s th mal whicl se rcl eag ly f th f m l w m t ppose tl t tl f mal h b t ally occas nally pref r th m re bea tif l m le nd that th se h e thus acq red tl b ty Th t th f m l in m t all th Ord rs w ld h the pow f rejecting any p t ul mal is prob bl from tl many ingular contr posse sed by th mal s, ch as gre t j ws, dh h ns, p s, l g ted l gs, & f r seiz ing th f mal f th se co tri hew th t tl re som d ffi lty th act, so that h co rre ce ld seem necessary J dg g from wl t w kn w f th percept po rs and ffecti ns f ari us insects th re

I then applied to Mr Wallace who has an innate genius for solving difficulties After some consideration he replied Most caterpillars require protection as may be inferred from some kinds being furnished with spines or irritating hairs and from many being coloured green like the leaves on which they feed or being curiously like the twigs of the trees on which they live Another instance of protection furnished me by Mr J Mansel Weale may be added namely that there is a caterpillar of a moth which lives on the mimosas in South Africa and fabricates for itself a case quite indistinguishable from the surrounding thorns From such considerations Mr Wallace thought it probable that conspicuously coloured caterpillars were protected by having a nauseous taste but [illegible] mely [illegible] rude [illegible] as fatal to them as if they had been devoured Hence as Mr Wallace remarks distastefulness alone would be insufficient to protect a caterpillar unless some outward sign indicated to its would be destroyer that its prey was a disgusting morsel Under these circumstances it would be highly advantageous to a caterpillar to be instantaneously and certainly recognised as unpalatable by all birds and other animals Thus the most gaudy colours would be serviceable and might have been gained by variation and the survival of the most easily recognised individuals

This hypothesis appears at first sight very bold but when it was brought before the Entomological Society[33] it was supported by various statements and Mr J Jenner Weir who keeps a large number of birds in an aviary informs me that he has made many trials and finds no exception to the rule that all caterpillars of nocturnal and retiring habits with smooth skins all of [illegible] all [illegible] When the birds rejected a caterpillar they plainly shewed by shaking their heads and cleansing their beaks that they were disgusted by the taste[34] Three con[illegible] moths were [illegible] by Mr [illegible] and were rejected though other kinds were eagerly eaten Thus the probability of Mr Wallace s view is confirmed namely that certain caterpillars have been made conspicuous for their own good so as to be easily recognised by their enemies, on nearly the same principle that poisons are sold in coloured bottles by druggists for the good of man We cannot however at present thus explain the elegant diversity in the colours of many caterpillars but any species which had at some former period acquired a dull mottled or striped appearance either in imitation of surrounding objects or from the direct action of climate &c almost certainly would not become uniform in colour when its tints were rendered intense and bright for in order to make a caterpillar merely conspicuous there would be no selection in any definite direction.

Summary and Concluding Remarks on Insects—Looking back to the several Orders we see that the sexes often differ in various characters the meaning of which is not in the least understood The sexes also often differ in their organs of sense and means of locomotion so that the males may quickly discover and reach the females They differ still oftener in the males possessing diversified contrivances for retaining the females when found We are however here concerned only in a secondary degree with sexual differences of these kinds.

In almost all the Orders the males of some species even of weak and delicate kinds are known to be highly pugnacious and some few are furnished with special weapons for fighting with their rivals But the law of battle does not prevail nearly so widely with insects as with the higher animals Hence it probably arises that it is in only a few cases that the males have been rendered larger and stronger than the females On the contrary they are usually smaller so that they may be developed within a shorter time to be ready in large numbers for the emergence of the females.

In two families of the Homoptera and in three of the Orthoptera the males alone possess sound producing organs in an efficient state These are used incessantly during the breeding season not only for calling the females but apparently for charming or exciting them in rivalry with other males No one who

33 *Proceedings Entomological Society* Dec 3 1866 p xlv and March 4 186[illegible] p lxx[illegible]

34 See Mr J Jenner Weir's paper on Insects and Insectivorous Birds in *Transact Ent. Soc* 1869 p [illegible] also Mr Butler's paper *ibid* p 27 Mr Riley has given analogous facts in the *Third Annual Report on the Noxious Insects of Missouri* 1871 p 148 Some opposed cases are [illegible] given by Dr Wallace and M H d'Orville see *Zoological Record* 1869 p 349

CHAPTER XII

SECONDARY SEXUAL CHARACTERS OF FISHES AMPHIBIANS AND REPTILES

We h now arri ed at th gre t sub-king d m of th V t b ta, and w ll comm nce th the lowest class, th t f fi.hes The males of plagio t m s fish s (harks, y) and f ch mæro d fishes are pro ded with laspers which serv to tain th f mal l ke the an us structures possessed by ma y f th lowe animals. Besid th laspe s, th males f many ays h clusters f tro g sharp spines n th ir h ads, and se ral row alo g the pper t urf ce f th pec toral fins. Th se are present in th mal f some pecies, wh ch ha th p rts f th bodies smooth They are ly t mporarily d loped during th breeding season and D Gü the uspects that th y ar bro ght to actio as prehensil rgans by th d bling inward and d nw rd f th tw des of th body It is remarkable fact th t th females and t the mal f som peci s, as f Raia la at ha th backs t dded with larg hook f rmed p s.

Am ... ... th f mal wl lst sh runs w th great swift ess th sandy beach, d tl re d po ts h sp n Th wid ly dist ct M nac thus copas prese ts som wh t an log stru ture Th mal as D G th inf rms me has l t f tiff traight p s, lik those of comb th d f th tail and th se in specim in hes l g w re nearly and half in hes in l gth th f mal has in th sam place l t f bristl s, which m y be compared th th se f tooth brush. I an tl spec M peron th mal has bru h lik that possessed by th f mal f th last pec h lst tl d f th tail in tl fe-mal are mooth I som th pecies f th sam genus th tail can be perce ed to b a l ttl ro gh ed in th mal and perfectly mooth th f m l and lastly in th rs, both se es ha mooth sides

Th male of many fi h fight f r the po ses-si n f the f mal s. Th s the mal st ckleback (Gasterosteu le rus) has been d scribed as mad with d l ght wl n the fem l come out of h r hiding place nd survey the n t wh ch h has made f h He darts r nd l in ev ry d rect o then to l is accum lated t ri l f the nest, then back gain i an

Th battles re at t mes de pe te r these puny comb tants fast n t ght h other f r se al seco ds, tumbli g e nd r gai until th ir t th ppe rs com plet ly exh ted W th th rougl tailed ti kl back (G t ack rus) th mal s whilst fighting w m ro d and round each tl h ti g and de oun g to p rce each otl with th aised l t ral pines. Th sam writ adds, tl b t f th se little f nes ery se re Th y also use th ir late al p n with s ch f tal ffect, th t I h e n during a b ttl bsol tely rip h ppo e t quite pen so th t h sank to th b ttom and d ed Wh n a fish is conqu red his g llant be ring f rsak s h m h s g y l urs fad w y and h hid l disgrace am g his peaceabl compan s, but f som t m th constant bject f his co q ro persec t n

Th m l salm is as p gnaci s as th littl t kl back and so th m le tro t as I l from D Gü th Mr Shaw saw a o-l nt co t t b tween tw m l lm n wl ch lasted th wh l d y and M R B ist, S p-rintend t f F h ries, informs m th t h has ft n w tched from th bridg t l rth th mal dr ng y th ri als, whilst th f m les w re spawni g Th males re con tantly figl ting and t aring each the the sp wning beds, and many so inj re each th r

Yarrell Hist. f Brit h F he ol 1836 pp 417 425 436 D (u ther f orm m that th pines R clavata are pec li t th female
The Americ Nat al st, Ap l, l 71 p 119

l<60 p 331

is no antecedent improbability in sexual selection having come largely into play but we have as yet no direct evidence on this head and some facts are opposed to the belief Nevertheless when we see many males pursuing the same female we can hardly believe that the pairing is left to blind chance—that the female exerts no choice and is not influenced by the gorgeous colours or other ornaments with which the male is decorated

If we admit that the females of the Homoptera and Orthoptera appreciate the musical tones of their male partners and that the various instruments have been perfected through sexual selection there is little improbability in the females of other insects appreciating beauty in form or colour and consequently in such characters having been thus gained by the males But from the circumstance of colour being so variable and from its having been so often modified for the sake of protection it is lifficult to decide in how large a proportion of cases sexual selection has played a part This is more especially difficult in those Orders such as Orthoptera Hymenoptera and Coleoptera in which the two sexes rarely differ much in colour for we are then left to mere analogy With the Coleoptera however as before r m l n
t e
n

ucs see a mutual attachment between the sexes that we find the males of some species possessing weapons for sexual strife others furnished with wonderful horns, many with stridulating organs and others ornamented with splendid metallic tints Hence it seems probable that all these characters have been gained through the same means, namely sexual selection With l e the
pains
can
l t iat they would act thus unless the display was of use to them in their courtship

When we treat of birds, we shall see that they present in their secondary sexual characters the closest analogy with insects Thus, many male birds are highly pugnacious, and some are furnished with special weapons for fighting with their ri l T organs
son for
The
quently ornamented with combs horns, wattles and plumes of the most diversified kinds and are decorated with beautiful colours all evidently for the sake of display We shall find that as with insects both sexes in certain groups are equally beautiful and are equally provided with ornaments which are usually confined to the male sex In other groups both sexes are equally plain-coloured and unornamented I a tly in some few anomalous cases the females are more beautiful than the males We shall often find in the same group of birds every gradation from no difference between the sexes to an extreme difference We shall see that female birds like female insects often possess more or less plain traces or rudiments of characters which properly belong to the males and are of use only to them The analogy indeed in all these respects between birds and insects is curiously close Whatever explanation applies to the one class probably applies to the other and this explanation as we shall hereafter attempt to shew in further detail is sexual selection

lo g t s, and t l g us projection t rns p ard f m tl po t, whi h, wl e tl j ws a l sed occ p s d p ty bet ee tl intermaxillary bo f th ppe j (fig and 8) In l this hange f tructure last ly d th breeding seaso b t n th Salm l, do of

th n In th se ld mal the j w becomes d l ped to an imm se hook lik projec t n, and tl t th g o t ul fan s, olt m re th half an inch l gth W th tl Europe n salm ccord g t M Ll yd tl t mpo ry hook l k tru tur sers to tre gth and protect th j ws, h n o m l ch g an th th d f l l ce b t t gre tly d l ped teeth f the m l Am n salm m y b comp ed w th tl tusks f many m l m mmals, and th y d t an ff th l an protectiv p rpose

ui at \ in a- t) th ad lt mal has sh rp pointed t th d ected back ds, wl l t th f th f m l ar b oad and fl t, and f rm pa m t so th t th se t th d ff th tw es f tl sam peci m tha l di tin t g f th sam f mily Th teeth f tl mal becom h rp ly wl li ad lt hilst g th broad d fl t lik tl se f th f mal \ so f q tl occ rs th seco dar se l h t rs, b th se f som pec l s (f in tan R bat) h n ad lt, possess l p po ted t th d h cl aract p pe t d prim rily gained by th m l pp t h l ce t m tted t th ff pri g f b th se Th teeth are lik ise po ted both se f R maculata, h t nly hen j t adult tl mal acq ring th m t an l g than tl f mal s. W hall h aft meet th analc g case ce tai b ds, which th mal acq re th pl m g comm to both se when ad lt, t som h t l g than d e th f m l W th th pec f th mal en wl ld n possess sharp te th d onseq tly th ad lts f

b th se es are p vided with b oad fl t teeth l k tl e f tl y u g and like th se of tl e m tur f m les f th above ment d pe ci ls tl e ray are b ld tro g and ac s fi h m y u pect th t tl males require th l rp teeth f fi ht n with th r rivals b t as they po many p ts modi fied d dapted f the p l on of tl e f m l t s poss bl th t th teeth may b used f th p pse

I re ard t e M Carbonnie mai ta tl t tl fem l of alm t ll f sl e

prinod nts th m l is n t ev n l alf as l g \ n many k d f fi h th mal l b t ally figl t t tle t is rp g th t tl y h n t g ally become la g id t ng than th f m l s through th ff t f se l sel t The mal ff f m tl sm ll f accord t M Carbon tl e liable t b d u ed by th fem l s f th own speci wh n carniv o a d n l bt by tl er pec s Incr ased iz m t l i som mann f more mportance to the f m l s tl an str gth and si ar t th m l s f fight g w th th m l and this pe haps t ll w f th prod t f a vast numb r f

In man peci th mal lon is orna m ted w th b ght col o tl m l b ght th mal than th f m le Th mal lso s som t m pro ded w th ppend g l h ppea t b f n m use to h m f tl d ary purposes f life than are th t l f th rs t tl p cock I m nd bted f m st f th f ll ing f ts to th kind ess f D Gu th Th re reason to s pect tl t m y trop cal fi h d ff ally n col u and tru tu and th re som triki g ase with B t l fi l Th m le C l l ymus ly has b n called th g mm d g t from ts brill ant g m lik col u Wh f h a ght f m tl sea th body y ll f n had s, t ped and potted w th d bl e ntl e l d th d rsal fi pal b tl l k l g t dinal band tl tral ca d l a d an l fi b g bl h bl k Th f mal rd d dra n t w co d red by Linnæus, d b many b q t n tur l ts, as d t ct p c t s f

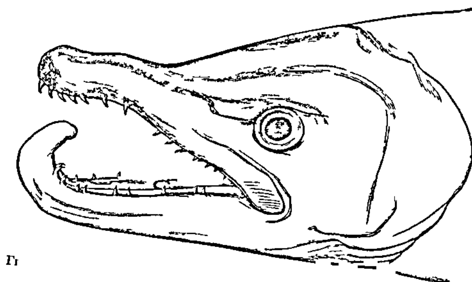
Yarrell, H to y f British F he l u. 1836 p. l

The Nat alist l ac cr l l nd l. i., 1866 p. 54

Scand navia Ad ent ol 1854 pp. 100 104.

See Y rr ll ccou t of th y his Hist ry f British Fishe l. 1836 p 416 th ll t figure d pp 42 432.

As q ted th F mer 1868, p. 369



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ı g season. n ecuted Dr Gunth r] „ Museum,

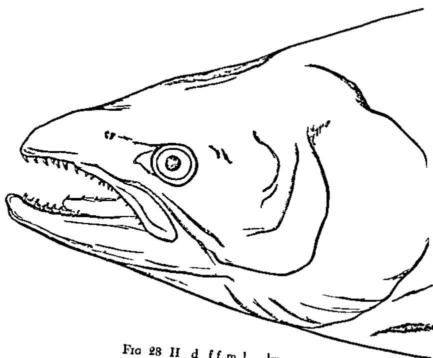


Fig 28 H d f f m l lm

as to cause the death of numbers many being seen swimming near the banks of the river in a state of exhaustion and apparently in a dying state [6] Mr Buist informs me that in June 1868 the keeper of the Stormontfield breeding ponds visited the northern Tyne and found about 300 d ad salmon all of which with one exception were males and he was convinced that they had lost their lives by fighting

The most curious point about the male salmon is that during the breeding season besides a slight change in colour the lower jaw

The *F eld*, J ne 29 1867 Fo Mr Shaw stat ments ee *Ed nbu gh Review* 1843 \ th pe enced bsers (S rop *D y f Salm F h g* p 60) r marks th t l ke th tag tl e m l w uld f he could keep all oth r m l s w y

lo g tes, and cartil gin project n turns p ard f m th point, hich l n the j re closed occ p a deep c ity bet ee th t rm llary bon s f tl uppe j (fig and 8) In o salm thi hange f t t re last nl dur g th l

th n rs. In these ld mal th j becom s d l ped to an mm nse hook lik projec tion, and tl teeth gro nt r gular fang oft m re th l alf an inch n l gtl W th th European alm according t M Ll y d the t mpo ary hook lik tr t se es t tre gth and protect th j wh n o mal charg an th r w tl w d f l l nce b t th gre tly d l ped teeth f th m l Am can salm m be compared w th tl t ks f many male m mmals and they in dic t an ff th l an protect p rpose

Th salm t th ly fi h in wl ch tl teeth d ff in th t se as th th case th man y I t th back (*R la t*) tl ad lt mal has harp pointed teetl direct l backwards, whilst th se f th f m l are b oad and flat, and f rm p ment so that these t th diff in th tw se f tl sam speci m re th ual d t t gen ra f th *sam famil* Th t th f tl mal becom harp nl l n h ad lt hil t ung th ar broad and fl t l k tl se of the f mal A so f eq tl occ n th seco dary se l h act b tl se f som pec f y (f nstance *R bat*) h ad lt, possess harp pointed teetl and here l aract p pe t and prim rily

maculata, b t nly wl en q t ad lt tl male acq ring th m t an l g than th f mal s. W sl all h afte meet w tl analogous case ertai b rds, in wh cl tl mal acq ir th pl m g comm n t b th sexe h ad lt t som h t l g than doe th f m l W th th pec f tl m le wh ld possess sharp t tl and onseq tl th ad lts f

b th e s are pro ded witl broad flat teeth like tl ose f th ung and like tho of the m tu f l of the abo m nti ed pe As tl e r y re bold tro g and r

fied and dapted f r tl preh on f tl e f m l t po bl tl t th teetl m y b u ed f tl pu pos

I regard t s M C b nn r na tain tl t tl fem le of alm t all f l t l g tha th al and Dr Gintl r loe n t kn w f gle tance h h tl l act ally larg tl ar tl e f mal W tl some prinodonts th m l not n half as l rg A i man k d f fi l tl n ale l b t ally fight tog tl r t urp g tl t th y h n t g ally become l g r a d tr ng tl an tl f m les th gl th ff t f se l sel ct Th m le ff from tl ir all f ccord g to M Carb n r tl y re l bl t b d red by tl e fem l f tl w pec s wh carni and l bt by th pec Incr ased iz must l in some man f more mportance t the f mal s, tl n tre gth and t tl m l f figl t g w th ther m l and this p l j t ll w f tl prod ct f vast numb f

In many pec th mal al e is rn m ted w th b ght col tl se are m cl bright m th m l th the f male The male

f th rs t th pe cock I m d bt d f m t f tl f ll g f ts t th ki d f D Guntl Th re i r aso to s pect tl t man trop l fi l d ff se ually n col and tru t re and th re are some t k g case w th B t h fisl Th male *C l l ym l y* has been lled th *g m e*

pal brown w tl d k l git dinal band tl t al dal d l fi b g bl l black Tl f mal so d d drag n t was co d ed b Linnæ s, and by many ub q t tur l ts, as a d t t pec s t f

Yarrell, *History f British F he* l 1836 p. l

The Nat alist I aco er *Island*, l. 1866 p. 54.

Scand navia *d entures* ol. i., 1854 pp. 100 104.

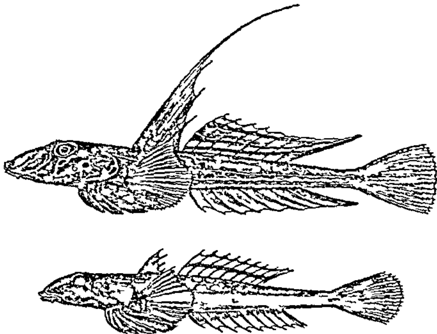


FIG 29 *Call o ymu lj* Upper figur mal l w figur fem l
N B Th lo er figure is mor reduc d th i the upp r

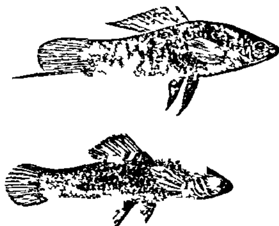
a dingy reddish brown with the dorsal fin brown and the other fins white The sexes differ also in the proportional size of the head and mouth n[1] the eyes [2] the extra ... 29) of the ... Mr W Saville Kent remarks that this singular appendage appears from my observations of the pecies in confinement to be subservient to the same end as the wattles cre ts and other abnormal adjuncts of the male in gallinaceous birds for the purpose of fascinating their mates [13] The young males resemble the adult females in structure and colour Throughout the genus Callionymus [4] the male is generally much more brightly spotted than the female and in several species not only the dorsal but the anal fin is much elongated in the males

The male of the *Cottus scorpius* or sea serpent, is slenderer and smaller than the female There is also a great difference in colour between them It is difficult as Mr Lloyd[1] remarks for any one who has not seen this fish during the spawning season when its hues are brightest to conceive the admixture of brilliant colours with which it, in other respects so ill favoured is at that time adorned Both sexes of the *Labrus mixtus* although very different in colour are beautiful the male being orange with bright blue stripes, and the female bright red with some black spots on the back

licnesia petenensis [1] the dorsal fin is greatly developed and is marked with a row of large, round ocellated bright-coloured pots whilst the same fin in the female is smaller of a different shape and marked only with irregularly curved brown spots In the male the basal margin of the anal fin is also a little produced and dark coloured In the male of an allied form the *Xiphophorus H lleri* (fig 30) the inferior margin of the caudal fin is developed into a long filament whic as I hear from D Günther is striped with bright colours This filament does not contain any muscles and apparently cannot be of any direct use to the fi h A in the case of the Callionymus the males whilst young resemble the

[11] I h e draw up this descr pti n from Yarrell s *Brit h F shes* v l i 1836 pp 261 d 266
Nat r July 1873 p 264
Catalogue f Acanth. F hes in the British Mu e m by D Günth r 1861 pp 138-151
[15] *Game Birds f Sweden, &c* 1867 p 466

[16] With respect t th a l th f ll g pec es I am d bt d to D ... see als his pape ... Fish f C tr l Am rica, *T ns t Zoolog al Soc* ... 1868 p 485



F G. 30 X phophorus helleri Upper figure male low figure f male.

adult f male in colour and struct re. Se ual differences such as these may be trictly com pared th those which are so freq nt with gallinaceous birds.

In siluroid fish, inhab ting th fresh w t rs of South Am rica, th *Plecostom barbatus*[13] (F 31) the male has t m th and inter perculum fringed with beard f tiff hairs, of hich th f male shows hardl trace These hairs re of th nature f scales. In another species of th sam g us, soft flexible tentacles project from th fro t part f th head of th male, which re abse t in th f male These t tacles are prolo g tions of th true skin, and th ref re are not h m l g us with th stiff hairs of th f rm species b t t can hardl be d bted that both serv th sam purpose What this purpose may be is difficult to co jecture rnam nt does not here seem probal le b t w can hardl ppose that tiff hairs and fl xible filament can be seful in any ordinary w to th males alone. I that strang m nst th *Ch mær mon strosa*, th male has hook shaped bo o the top of th head, directed f rwards, w th ts nd rounded and co red with sharp spines in the f male this cro n is alt ethe abse t, b t hat ts use ma be to th mal is tt ly unknown [15]

Th tru tures as et ref rred to are per man nt in th mal aft r he has arn ed t maturity b t with some blenn s, and in anoth allied g nus,[16] a crest is d l ped on th h ad f th male nly d rin th breeding season, and the bod at th sam time becomes m re brightly-col ured Th re can be l ttle d ubt that this rest serves as a temporary sexual rnam t, f th f male does not xhib t trace f it. In th species of th same genus both se es possess a crest, and n at least peci n the se is th s pro ided In many f the Chromidæ fo instance in Geophagu and especially in C chla, th mal s, as I hear from Professo Agassiz, ha a con p cu protuberance n th forehead wh ch is wh lly wantin in th f males and in th ung males. Professor Agassiz adds, I ha e ft n observed these fishes t the time of pawning wh th protuberance is largest and t other seasons wh n t is t tall want ing and th tw se sh w n diff re ce what in th tline of th profile of the head I could ascertain th t t b e es any spe cial function, and th Indians n th Amazon know n thing abo t ts use " These protube ance resembl in their periodical ppearance th flesh carbuncles n the heads f certain birds but wh th tl ey serv as rnam nts must remain t present d ubtful.

I hear from Professo Agassiz and D Gun ther that th males f those fishes, which

[13] Dr Günther makes this remark, *Catalogue f Fishe the British M seum* vol. iii., 1861 p. 141
[14] See Dr Günther this g us, *Proceed g of the Zoological Society*, 1868, p. 232.
[15] F Buckland, *Land nd W ater* July 1868, p. 377 th figure Many other cases could be added of structures peculiar t the male, of hich the uses are not known.

[16] Dr Gü ther *Catalogue of Fishe* vol. iii., pp 221 nd 240.
[17] See also *A J urney B azil*, by Prof. and Mrs. Agassiz, 1868, p. 220.



Fig 31 Pl t m b b t
Upper figu l d f n l l figu f m l

differ permanently in colour from the females often become more brilliant luring the breed ing season This is likewise the case with a multitude of fishes the sexes of which are iden tical in colour at all other seasons of the year The tench roach and perch may be given as instances The male salmon at this season is marked on the cheeks with orange-coloured stripes which give it the appearance of a Labrus and the body partakes of a golden orange tinge The females are dark in colour and are commonly called black fish [2] An analogous and even greater change takes place with the *Salmo e iox* or bull trout the males of the char (*S umbla*) are likewise at this season rather brighter in colour than the females [3] The colours of the pike (*E s x tic latus*) of the United States, especially of the

[2] Y rr ll *Hist y f B itish Fish* v l 1836 pp 10 1 35

[3] W Th mpso in *A als nd M g ne f Nat l H t y* l v 1841 p 440

male become, d rin th breeding-season, exceedingly intense brilliant and iridescent.[4] Another striking instance o t of man is af forded by th mal stickleback (*G terosteus leurus*) which is described b M Waring ton, as being th n be tif l bey nd d scrip tion. The back and es f th f m l are simply brown and th belly white. Th of the male on th th r hand, are f th most splendid green, ha ing a m tallic l tre like the gree f th rs f som humming birds. Th throat and bell are of bright crimson, th back f an ash green, and th whole fish ppears as tho h t w re som what trans luce t and glowed with an int rnal incan descence. Aft th breeding season these colours all change th throat and belly become of pale red, th back m re green, and th glowing tints subsid

W th respect to th courtship of fish s, othe cases ha bee observed since th first ed t of this book ppeared besides th t alread p of th tickleback. Mr W S K t says that the male of th *Labru mixt* whi h, as w ha seen, diff rs in col from tl f mal makes deep hollow in th sand of th tank, and the ndea rs in th most persuasi mann to ind ce f mal of th sam species t share t th him wimmin ba kwards and f rward betwee h and th compl ted nest,

leaden-black th th n retire from th sl oal, and ca t bollow as n t. Each mal now mo t gilant guard his respecti

tended w th pawn, and th se h d urs b all tl m ans l po t l re san l t his prepared hollow and th re to d posit th myriad with which th are lad n, which he the protects and guard with th greatest care [3]

A more triking case of co rtsh p as w ll as of di pla by th males of Chi ese Macropus has been gi b M Carbonni who care fully observed these fishes nd confin m t.[2] The males are most be tifull coloured more so than the females. During th breeding se son th y contend f r the possessi n of tl e fe males and, in the a t of courtship expand th fins, which are spotted and rname ted with bri htly coloured ra s, in the same man n according t M. Carbonni as tl e pea cock. Th y th n lso bound about th f males w th m h acit and appear by *l' talage d leur rire couleurs chercher a attirer l'at tention de f m ll le q lle ne pa a nt nd fferent m nig l e nag ut tec ne molle lenteu les mal et mbl it e compla d ns le ge* Aft the male has w n his bride he makes a littl disc f froth by blowing ai and mucus out f hi m uth He th n collects the f rtilised o a, dropped by th f mal in hi m th and this

hab t h riginated b t th diffi ult much diminished when w kn w that th re are fi hes which thus collect and carry th gg f if d la ed b any ause in d pos ting th m th hab t f h tching them in th ir m ths might ha been acquired

To return t ur m re immedi t ubject Th case stand thus f mal fishes, as far as I can l arn, n e willingl pawn cept n th prese ce f th mal and th males n f rtilise th cept in th presence f th f mal s. Th males fight f th possess of th f mal s. In many pecies, th males whilst ung resembl th f males in col ur b t wh n adult becom m ch m re brilliant and retain th ir col rs thro gh ut lif In ther spec es th males becom bri ht than th fe males and th rwise m re highl rnam ted nl l ring th season f l e. Th mal sed l sl court th f males, and in n case as w ha seen, tak pains in displaying th ir be ty bef re th m. Can t be beli ed that th y w uld thus act t n purpose d ring th ir courtship And this w ld be th case unless th f males rt som ch ce and select tl se males wh h pl ase eit th m most. If th f m l rts ch h ce all the abo facts on the rnam tat f th males becom t once int lligbl by th aid of sexual selecti n.

[a] The America Agricult alist, 1868, p. 100
Annals nd M g of Nat. Hist., Oct., 1852.
Natur May 1 73, p. 25.
Bull de la Société d' Accl matation, Paris, July 1869, and J n., 18 0.

We have next to m

aw of the equal transmission of characters to both sexes be extended to those groups in which the males and females are brilliant in the same or nearly the same degree and manner In such a genus as Labrus which includes some of the most splendid fishes in the world—for instance the peacock Labrus (*L pavo*) describ d [28]

y accept this belief for we have seen that the sexes in at least one pecies of the genus differ greatly in colour With some fishes as with many of th

ithout the aid of selection of any kind The gold fish (*Cyprinus auratus*) judging from the analogy of the golden variety of the common carp is perhaps a case in point as it may owe its splendid colours to a single abrupt variation due to the conditions to which this fish has been subjected under confinement It is however more probable that

d through
has been

e period [29]

Under natural conditions it does not seem probable that beings so highly organised as fishes and which live under such complex relations should become brilliantly coloured without suffering some evil or receiving some benefit from so great a change and consequently without the intervention of natural selection

What then are we t co in regard to
cl are splen
cheves that
quent re ls

and other brightly-coloured organisms abound are brightly coloured in order to escape detection by their enemies but according to my recollection they were thus rendered highly conspicuous In the fresh waters of the tropics there are no brilliantly-coloured corals or other organisms for the fishes to resemble yet many species in the Amazons are beautifully coloured and many of the carnivorous Cyprinidæ in India are ornamented with bright longitudinal lines of various tints [31] Mr M'Clelland in describing these fishes, goes so far as to suppose that the peculiar brilliancy of their colours serves as a better mark for king fishers terns and other birds which are destined to keep the number of these fishes in check but at the present day few naturalists will admit that any animal has been made conspicuous as an aid to its own destruction It is possible that certain fishes may have been rendered conspicuous in order to warn birds and beasts of prey that they were unpalatable as explained when treating of caterpillars but it is not I believe known that any fish at least any fresh water fi

or which both sexes are brilliantly coloured is that their colours were acquired by the males as a sexual ornament and were transferred equally or nearly so to the other sex

We have now to consider whether when the male differs in a marked manner from the female in colour or in other ornaments, he alone has been modified the variations being inherited by his male offspring alone or whether the female has been pecially modified and rendered inconspicuous for the sake of protection such modifications being inherited only by the females It is impossible to doubt that colour has been gained by many fishes as a protection no one can examine the peckled upper surface of a flounder and overlook its resemblance to the sandy bed of the sea on which it lives Certain fishes, moreover can through the action of the nervous system change their colours in adaptation to surrounding objects, and that within a short time [32] One of the most striking instances ever recorded of an animal being protected by its colour (as far as it can be judged of in preserved specimens) as well as by its form is

u n Ind n Cyprin dæ by M M'Cl lland, *Asiatic*

ricalry as to its olo and as source f profit. *Re Ie* L part 1 1839 p 230

[29] *Westminster Rev w* Jul 1867 p 7

[32] G I ch t *LI 11 t* N 1 1871 p. 134

that given by D Gü th r[33] f p pe-fish, which, with ts reddish streami g filaments, hardly distinguishabl from the sea weed to hich t clings with ts preh nsile tail. B t th questio now und cons d rat on is wh th the females alo ha e been mod fied f thu object. We can see that se will not be modified thro gh natural selection f r the sak of protectio more than th oth sup- posing both to arv unless sex is exposed for longer period to dang has less powe of escaping from ch dang than th th and t does not ppear that with fish th sexes diff in these respects. As far as th re is any diff rence, th males, from being g n rally smaller and from wand ring more bo t, are sposed to gre te dang than the f males and yet, wh th se es diff the mal are almost alw ys th m re consp cu usly col ured Th o are f rtilised immediately afte l

pare ts, so that th mal and f mal s, as far as vipositio is co cerned, are equally posed t dang and both are equall m portant f th prod t f f rt l co seq ently th more less brightl -colo red ndi iduals of th se w uld be eq allv liabl to be d stro ed preserved and both ould ha an equal fi nce n th col rs of thei offspri g

Certain fishes belo gin t se al famil es, mak nests, and som of th m tak care f their ung wh hatched Both sexes f the bright-coloured *Cre ilabrus massa* and *melops* ork t ether in b lding their nests w th sea- eed, shells, &c[34] B t th males of certain fishes d all th w k and aft rward tak ex lusi charge of th ung This is th case th the dull-colo red gob es,[35] in which th sexes are not kno n t differ in colo and likew se with th ti kleb cks (Gast rost) wl ich tl male become brilliantly colo red l rin the sawni g seaso Th mal of th smo th tailed tickl back *G leiurus*) pe f rm th t es of rse with ex mplary care and ilance d rin lo g tim and continual emplo ed in g tl l adin back

th voung to the nest, when they tray too far H courageously dri es aw y all n mi in- cl ding th f males of his own species. It w uld indeed be no small rel ef to the mal f th f mal aft d po ting h r eggs, were m medi t l d red b some enemy f r he f rced incessantly t drive h r from the e t.[37]

Tl e males f certain th r fisl es inhab ting South Am rica and Ce l n b lo ging to two distinct Ord rs, ha th e traordinary h b t of hatching within th m uth o bran hial ca t es, th egg laid b th females.[38] I am inf rmed b Prof sso Agas iz th t the males of th Amazonian pecies whi h f llow th hab t, "n t onl re g n ally brighte than th f mal s, b t th diff re ce s gre t r t tl e spawning season than at any othe time Th pecies of Geophagus act in the sam mann r and in this genus, a consp cu us prot berance becomes de loped n th f rehead f th males during the breeding season. With tl vari us pecies of chromids, as Professor Agassiz lik wise inf rms m sexu l diff rences in colour ma be observed wh th r the l y thei gg n th w ter am g aquatic plant or d posit them in h es, l ing th m to come o t with t furth care build shallow n ts

r with all th species f chrom d it th mal al which sits n th ggs is not known It is, howev manifest that th fact of the ggs bein protected u protected b th parents, has had littl no infl ence th diff re ces in colour between th se es It is f rth manifest, in all th cases whi l th males tak clusi charg f th t and un th t th destruction of the bri ht r col ured males w uld be far more infl ntial n th charact f th race, than th destruc tio f th brighte -coloured f males f the

Proc Zoolog Soc 1865, p 327 pls xi and xv Yarrell, *British F he* ol p 11
According t the observ tions of M Gerbe see Günther *Record of Zoolog Literature* 1865, p 194
[36] uvier *R ne Animal* ol ii 1 29 p 242.

See M W n rt most int rest g descrip- tio of th habits of th *Gasterosteus le ur* Annal nd *J gazine of Nat H story* N ve ber 185
Prof. Wyman, *P oc Bosto Soc of Nat. Hist* Sept. 1 1857 Also Prof Turner *J rnal f Anatomy nd Physiology* N 1 1866 p 8. D Günther has l kew se d scribed other cases.

the males are more conspicuously coloured than the females

In most of the Lophobranchii (pipe fish Hippocampi &c) the males have either marsupial sacks or hemispherical depressions on the abdomen in which the ova laid by the female are hatched The males also shew great attachment to their young[3] The sexes do not commonly differ much in colour but Dr Günther believes that the m

ase for the female is much more vividly coloured and spotted than the male and she alone has a marsupial sack and hatches the eg so that the female of Solenostoma differs from all the other Lophobranchii in this latter respect

on of character in the female should be an accidental coincidence As the males of several fishes which take exclusive charge of the eggs and young are more brightly coloured than the females and as here the female Solenostoma takes the same charge and is brighter than the male it might be argued that the conspicuous colours of that sex which is the more important of the two for the welfare of the offspring must be in some manner protective But from the large number of fishe of which the males are either permanently or periodically brighter than the females but ant for the the female When we treat of birds we shall meet with analogous cases where there has been a complete inversion of the usual attributes of the two sexes and we shall then give what appears to be the probable explanation namely that the males have elected the more attractive females instead of the latter having elected in accordance with the usual rule throughout the animal kingdom the more attractive mal s

On the whole we may conclude that with most fishes in which the sexes differ in colour or in other ornamental character the males originally varied with their variation transmitted to the same sex and accumulated through sexual election by attracting or excit ing the females In many cases however such characters have been transferred either partially or completely to the females In other case again both sexes have been coloured alike for the sake of protection but in no instance does it appear that the female al

are known to make various noises, some of which are described as being musical Dr Dufossé who has especially attended to this subject says that the sounds are voluntarily produced in several ways by different fishes by the friction of the pharyngeal bones—by the vibration of certain muscles attached to the swim bladder which serves as a resounding board—and by the vibration of the intrinsic muscles of the swim bladder By this latter means the Trigla produces pure and long drawn sounds which range over nearly an octave But the most interesting case for us is that of two species of Ophidium in which the males alone are provided with a sound producing apparatus consisting of small movable bones with proper muscles in connection with the swim bladder The drumming of the Umbrinas in the E be nd e n

ing time and that it is possible by imitating it to take them without bait From this statement and more especially from the case of Ophidium it is almost certain that in this the lowest class of the Vertebrata as with so many insects and spiders sound producing instruments have at least in some cases, been developed through sexual selection as a means for bringing the sexes together

AMPHIBIANS

URODELA —I will begin with the tailed amphibians The sexes of salamanders or newts often differ much both in colour and structure In some species prehensile cl are developed on the fore legs of the males during the breeding season and at this season in the male

[3] Yarrell History of British Fishes 1836

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Triton palmipes the hind feet are provided with swimmin web, which is almost completel absorbed durin th winter so that their feet the resembl those of th f male.[a] This structure no d ubt aid th mal in his eager search and pursuit of th f male Whilst courtin, her h rapidl vibrates the nd of his tail. W th our common newts (*Triton punctatus* and *cristatus*) a deep, much ind nted crest is developed along th back and tail f th mal during the breedin, season, which disappears during the wint Mr St Geor Mi art in forms me that t is not furnished w th m scles, and therefore cannot be used f locomotion. As durin, the seaso of courtship t becomes ed ed with bright colours, there can hardly be doubt that t is masculine ornament. In man pecies the bod prese ts trongly contrasted, thou,h lurid tints, and these becom more vivid during th breedin, season. Th male for instance of our commo little n wt (*Trito punctatus*) is brownish-gre abo passing int llow bene th, which in th pring becomes rich bright rang marked erv here th round dark pots. The ed of the crest also is then tipped with bright red or violet The f male is usuall of a llo ishbro colour w th sca t red brown d ts, and the lo urface is oft quit plain.[b] The oun are obscurel tinted Th are f tilised d rin the act of deposit n, and are not subsequently tended by eithe parent. W may

th ref re conclude that the males have acquired th ir trongl marked colours and ornamental ppendages throu,h sexual selecti n these being transmitted th r to th male off pring alone, r to both sexes.

ANUR or BATR CHIA —W th man frogs and toads the colours d ntl serve as a protection, such as th bri ht green tints of tree frogs and the obscure m ttled shades of many ter restrial speci s. Th most conspicu usly-coloured toad which I ev saw th *Ph ynisc nigricans*[c] had th wh le ppe urface of th body as black as ink, with th soles of th feet and parts f th abd m n potted w th the brightest rmilion. It crawled about th bare sandy pen gras y plains of La Plata und r a scorching un, and could n t fail to catch th f ry passin creature These col urs are probabl ben ficial b makin this animal known to all birds of prey as nauseous mouthful.

In Nicaragua th re is a littl fro dressed in bright h rv of red and bl e whi h does not conceal tself lik most th species, but h p abo t durin th d tim and M Belt sa that as soon as he saw ts happy sense of security h f lt sure th t t was u table. Aft se ral trials h succeeded in t mptin a un d ck to snatch up a oung on b t t was instantl rejected and th d k w nt about j kin ts head as if tryin to throw off som unpleasant taste.

W th respect to sexual diff rences f colour

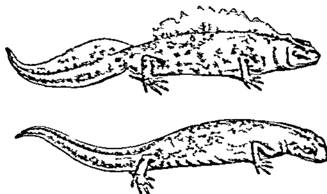


FIG. 32 *Triton cristatus* (half natural size, from Bell' *History of British Reptiles*).
Upper ure male during the breeding seaso lower figure female

[a] Bell, *History of British Reptiles*, 2nd ed., 1 49, pp. 156-1 9.
[b] Bell, *History of British Reptiles*, 2nd ed., 1849, pp. 146, 151.
[c] *Zoology of the Voy of the Beagle* 1843. Bell, ibid., p. 49
[d] *The Naturalist Nicaragua*, 1874, p. 321

Dr Günther does not know of any striking instance either with frogs or toads yet he can often distinguish the male from the female by the tints of the former being a little more in tense Nor does he know of any striking difference in external structure between the sexes excepting the prominences which become developed during the breeding season on the front legs of the male by which he is enabled to hold the female [47] It is surprising that these animals have not acquired more strongly marked sexual characters for though cold blooded their passions are strong Dr Günther informs me that he has several times found an unfortunate female toad

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oirman in Gies en fighting all day long during the breeding season and with so much violence that one had its body ripped open

Frogs and toads offer one interesting sexual difference namely in the musical powers possessed by the males but to speak of music, when applied to the discordant and overwhelming sounds emitted by male bullfrogs and some other species seems according to our taste a singularly inappropriate expression Nevertheless certain frogs sing in a decidedly pleasing manner Near Rio Janeiro I used often to sit in the evening to listen to a number of little Hylæ perched on blades of grass close to the water which sent forth sweet chirping notes in harmony The various sounds are emitted chiefly by the males during the breeding season as in the case of the croaking of our common frog [48] In accordance with this fact the vocal organs of the males are more highly-developed than those of the females In some genera the males alone are provided with sacs which open into the larynx [9] For instance in the edible frog (*Rana esculenta*) the sac are peculiar to the males and become when filled with air in the act of c

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whilst that of the female is only a slight groaning noise [0] In the several genera of the family th

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REPTILES

CHELONIA —Tortoises

in some the plastron or lower surface of the shell of the male is slightly concave in relation to the back of the female The male of the mud turtle of the United States (*Chrysem*

t

of the Galapagos Islands (*Testudo nigra*) the males are said to grow to a larger size than the females during the pairing season and at no other time the male utters a hoarse bellowing noise which can be heard at the distance of more than a hundred yard the female on the other hand never uses her voice [3]

With the *Testudo elegans* of India it is said that the combats of the males may be heard at some distance from the noise they produce in butting against each other [53]

CROCODILIA —The sexes apparently do not differ in colour nor do I know that the males fight together though this is probable for some kinds make a prodigious display before the females Bartram[54] describes the male alligator as striving to win the female by splashing and roaring in the midst of a lagoon swollen to an extent ready to b

ng his feats of war During the season of love a musky odour is emitted by the submaxiliary glands of the crocodile and pervades their h [55]

knows of no other difference in external structure In regard to colour he can almost always distinguish the male from the female by his more strongly pronounced tints thus the black zig ag band on the back of the male

[47] (Dr

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[48] Hist. of British Reptiles 1849 p 93

[49] J Bishop in Todd's *Cyclopædia of Anatomy and Physiology* vol iv p 1503

[50] Bell, ibid pp. 112-114

M C J Maynard the American Nat Dec 1869 p

[52] See J of Research during the voyage of the B 1845 p 384

[53] Dr Günther Reptiles of British India 1864 p

[54] Travels through Carolina 1791 p 128

[55] Owen Anatomy of Vertebrates vol i 1866 p

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English viper is more distinctly defined than in the female. The diff rence is much plainer in the rattle snakes of N Am rica, th male of which, as the keeper in th Zoological Gard ns showed me, can at nce be distinguished from the female by having m re lurid y llow about its hole body In S. Africa the *Bucephalus capensis* presents an analogous diff rence for the female is ne r so fully aner ted with yellow the sides as the male. [46] Th mal of the Indian *Dipsas cynodon*, on th ther hand, is blackish-brown, with th bell partl black, hust the female is reddish or y ll wish-oli ith the belly eith unif rm llowish or marbled with black. In the *Tragops dispar* of the same country the mal is bright green, and the female bronze-coloured.[47] N d ubt th

sam places

colours of many kinds, for instance of th common English snak and pe sers to conceal them and this is still m re d ubtful w th the man foreign pecies which are coloured with extreme elegance Th colours of certain species are ry diff rent in th adult and young states.[48]

During the breeding season th anal scent glands of snakes are in acti functi n [49] and so t is with the sam glands in lizards, and as have see with th submaxil ary glands of crocodiles. As the males of most animals search for the f males, these odorif rous glands probably serve to excite or charm the f male rath than to guid her to the pot wh re th male may be found. Male snakes, though ppearing so sluggish, are amorous f man ha been observed crowding round th sam f male and round her d ad body The are not kn wn to fight tog the from ri alry Their intellectual powers are highe than might ha been anticipated. In th Zoological Gardens they soon learn not to trik t the iron bar w th hich their cages are cleaned and D Keen of Philadelphia informs m that som snakes hich he kept learned aft f ur or fi times to void noose w th hich th y were at first easl caught. An excellent observ in Ce lon, Mr E. Layard, saw[60] a cobra thrust ts head through a narrow hole and swallow a toad. "W th this encumbrance he could n t with draw himself finding this, he relu tantl disgorged the precious morsel, which began to m e off this was too much f r snake philosoph to bear and th toad was again seized, and again was th nake aft viol nt efforts to escape compelled to part with ts pre This time, h we e a lesson had been l arnt, and the toad was seized by on leg, withdrawn, and then swallowed in triumph."

The keeper in the Zoological Gardens is positi that certain snakes, for instance Crotalus and Python, distinguish him from all other persons. Cobras k pt tog th in th sam ca e apparently feel some attachm nt towards each oth r

It does not, howe er follow because snakes have some reasoning power trong passions and m tual affection, that th y should likewise be nd wed with sufficient tast to admire brilliant colours in their partners, so as to lead to th adornm nt of th species through sexual selection. N rth less, t is difficult to ac co t any other mann for th extrem

well rem mbe how much surprise I f lt at the bea ty of the first coral-snak which I saw gliding across path in Brazil. Snakes coloured in this peculiar manner as Mr Wallace states n th authority of Dr Gunther [52] are f und nowhere lse in th wo ld except in S. America, and h re no less than four genera occur One of these Elaps, is enomous a second and widely distinct genus is doubtfully venom us, and the two others are quit harmless. Th species belonging to these distinct gen ra inhab t the sam districts, and are so lik each other that no one b t naturalist would distinguish th harmless from the poisonous kinds." Hence, as M Wallace beli es, the innocuous kinds ha probably acquired their colours as protection, n th principle of imitation for they would naturall be tho ght dangerous by their nemies. The cause how of the bright colours of the venomous Elaps remains to be explained, and this may perhaps be sexual selection.

[46] Sir Andrew mith, *Zoology of S Africa, Reptilia*, 1 8, pl x.

[47] Dr A. Gunther Reptiles of British India, Ray Soc 1864, pp. 304, 308.

[48] D toliczka, *J rnal of Asiatic Society of Bengal*, vol xxxix, 15 0, pp. 205, 211

[49] Owen, *Anatomy of Vertebrates*, vol i., 1866, p. 615

[50] "Rambles in Ceylon," in *Annals and M gazine of Nat ral History* 2nd series, vol ix., 1852, p. 333.

[51] Dr Günther *Reptiles of British India* 1864, p. 340.

[52] *Westminster Review* July 1 1867 p. 32.

Dr Günther does not know of any striking instance either with frogs or toads yet he can often distinguish the male from the female by the tints of the former being a little more intense Nor does he know of any striking difference in external structure between the sexes excepting the prominences which become developed during the breeding season on the front legs of the male by which he is enabled to hold the female [47] It *is surprising that these* animals have not acquired more strongly marked sexual characters for though cold blooded their passions are strong Dr Günther informs me that he has several times found an unfortunate female toad dead and smothered from having been so closely embraced by three or four males Frogs have been observed by Professor Hoffman in Giessen fighting all day long during the breeding season and with so much violence that one had its body ripped open

Frogs and toads offer one interesting sexual difference namely in the musical powers possessed by the males but to speak of music when *applied to the discordant and over*whelming sounds emitted by male bullfrogs and some other species seems according to our taste a singularly inappropriate expression Nevertheless certain frogs sing in a decidedly pleasing manner Near Rio Janeiro I used often to sit in the evening to listen to a number of little Hylæ perched on blades of grass close to the water which sent forth sweet chirping notes in harmony The various sounds are emitted chiefly by the males during the breeding season as in the case of the croaking of our common frog [48] In accordance with this fact the vocal organs of the males are more highly-developed than thos of the females In some genera the males alone are provided with sacs which open into the larynx For in*stance in the edible frog (Rana esculenta)* the

of the head near the corners of the mouth The croak of the male is thus rendered exce d ingly powerful whilst that *of the female is* only a slight groaning noise [50] In the several genera of the family the vocal organs differ considerably in structure and their development n all cases may be attributed to sexual selection

REPTILES

CHELONIA —Tortoises and turtles do not offer well marked sexual differences In some species the tail of the male is longer than that of the female In some the plastr n or lower *surface of the shell of the male is slightly con*cave in relation to the back of the female The male of the mud turtle of the United States (*Chrysemys picta*) has claws on its front feet twice as long as those of the female and these are used when the sexes unite [51] With the huge tortoise of the Galapagos Islands (*Testudo nigra*) the males are said to grow to a larger size than the females during the pairing season and at no other time the male utters a hoarse bellowing noise which can be heard at the distance of more than a hundred yard the female on the other hand never uses her voice [52]

With the Testudo elegans of India it is said that the combats of the males may be heard at some distance from the noise they produce in butting against each other [53]

CROCODILIA —The sexes apparently do not differ in colour nor do I know that the males fight together though this is probable *for*

to an extent ready to burst with its head and tail lifted up he springs or twirls round on the surface of the water like an Indian chief rehearsing his feats of war During the season of love a musky odour is emitted by the submaxillary glands of the crocodile and pervades their haunts [55]

OPHIDIA —Dr Günther informs me that the males are always smaller than the females and generally have longer and slenderer tails but he knows of no other difference in external structure In regard to colour he can alm t *always* di*stinguish the male from the female* by his more strongly p onounced tints thus the bl k zigzag ban l on the back of the male

J Bisl p Toud Physiol gy l iv p 1 03

[48] B ll, ibid pp 112-114

[51] Mr C J M y rd th Am rican Nat Dec 1869 p

[52] y J l f I l d g th Voy ge f th B gl 184 p 384

[53] D Gü th R ptil f Brit h I di 1864 p

T l th gh C ol d 1 91 p 128

[55] O l to y f V t b t v l i 1866 p 615

animal is xcited Th y occ r i both se es, b t are best de l ped wh tl mal ar i s t mat ntv t which g th m ddl ppe d age is som time tw ce as l ng as the head Most of th peci lik wise h e a l w re t h eck d this is much m re

during th pring and if on is caught, th the falls from the tree t th ground and allow tself to be capt ed w th impunity —I presum from d pair[44]





FIG 54 *Ceratophor stodd ti* Uppe figure, male l wer figure f mal

colo b t ass m p rpl sh ti t wl tl animal cited In tl ad lt m l f tl l t te pec th h rn half an el l gth, b t t is f quit min t size in th f mal d tl y g These ppendag s, as D Gü ther has remarked t m y be compared th th comb f gallinaceo b rds, and pparc tly serv as rn m ts.

All th foregoi g tat m ts d quot t s, re ard t Coph tis, tana nd Draco as ll as th foll g fact in regard t Cerat ph ra d Cha mæleon, are from D Gü he himself from h mag ifice ork the R pt les of British I dia, Ra Soc 1864 pp. 122, 130 135

M S nhoe, *Proc. Zoolog Soc* 1870, p. 240

In the g nus Chamæleon we come t tl e acm f d ff rence t tween tl sex s. Th uppe pa t of tl e kull f tl mal *C b furcus* (fig 5) an nh b tant f Mad gasc s pro- c r t sol d bony project

Chamæle oweri (fig 6) from th t oas f Afr ca the mal b ars on l nout an l f reh ad three curi us h rn f wh ch tl e f male has n t a trace Tl se h rn consist f an resce ce f bone co red tl a mooth h th f rming pa t f th g n ral int gume ts f the body so tl t tl y are de t cal in truct re w th th se f a b ll g at r otl l ath h ed rum ant Alth gl th three l rns d ff r so much n ppe rance from tl e two gre t prol g ti ns f th kull n *C b f rcus* w can hardly d ubt tl at they serv the same g eral p rpose n th eco omy f th se two animals. Th first conjecture which will occur t ry one s th t they are used by th mal s fo fight g t g th r and as tl se an m ls are ry q arrelsome th i rol bly co rect vi w M T W Wood

re ted f a time and aft rward continued th b ttl

W th many l rd the se d ff l ghtly in col th tints and tr pe f th males b brighter and m e disti tly d fi ed than in th f m l Tl s, f in tance the case w th th abo Coph ti d w tl tl l *thodact yl pensis* f S Africa. In a C dyl f th l tt co ntry th m l

ri pa) th d sid f th body nd ba f th t l th mal ar b ght ang pot ted w th black in th f m l tl se parts re pal g l gree w th t pot W h see that tl n l al f S tan pos ess a throat po ch and this pl nd dly t nted w th bl black, and red In th *P oct t tus* t is f Chil th mal al s marked w th

[44]D B hh lz, *M natsbericht K P eu Al d.* J 18 4 p 78.

B ll, *History f British Reptile* 2 d ed., 1849 p. 40

Snakes produce other sounds besides hissing The deadly *Echis carinata* has on its si les some oblique rows of scales of a peculiar structure with serrated edges and when this snake is excited these scales are rubbed against each other which produces a curious prolonged almost hissing sound [63] With respect to the rattling of the rattle snake we have at last some definite information for Professor Aug hey states [64] that on two occasions being himself unseen he watched from a little dis tance a rattle snake coiled up with head erect, which continued to rattle at short intervals for half an hour and at last he saw another snake approach and when they met they paired Hence he is satisfied that one of the uses of the rattle is to bring the sexes together Unfor tunately he did not ascertain whether it was the male or the female which remained station ary and called for the other But it by no means follows from the above fact that the rattle may not be of use to snakes in other ways as a warning to animals which would otherwise attack them Nor can I quite dis believe the several accounts which have ap peared of their thus paralysing their prey with fear Some other snakes also make a distinct noise by rapidly vibrating their tails against the surrounding stalks of plants and I have myself heard this in the case of a Trigonocepha lus in S America

LACERTILIA —The males of some probably of many kinds of lizards fight together from rivalry Thus the arboreal *Anolis cristatellus* of S America is extremely pugnacious During the spring and early part of the summer two adult males rarely meet without a contest On first seeing one another they nod their heads up and down three or four times and at the same time expanding the frill or pouch beneath

d

a

t

at each other furiously rolling over and over and holding firmly with their teeth The con flict generally ends in one of the combatants losing his tail which is often devoured by the

the general rule with lizards of all kinds The

[63] Dr A d rson P oc Zoolog Soc 1871 p 196

[64] The Americ N t list 18 3 p 85

[65] M N L Aust n k pt th n ls al f a con der ble time see Land nd W t July 1867 p 9

male alone of the *Cyrtodactylus ri bidus* of the Andaman Islands posses es ore anal pores and these pores judging from anal gy probably serve to emit an odour [66]

various

above

a crest

d can be

erected at pleasure but of this crest the female does not exhibit a trace In the Indian *Coph tis ceylanica* the female has a dorsal crest though much less developed than in the male and so it is as Dr Günther informs me with the fe males of many iguanas chameleons and other lizards In some pecies however the crest is equally developed in both sexes as in the *Iguana tuberculata* In the genus Sitana, the males alone are furnished with a large throat pouch (fig 33) which can be folded up like a

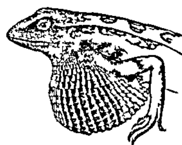


FIG 33 *S ta m or* M l w th the gular pouch p nded (fr m Gü th r *Rept l s of Indi*)

fan an l is coloured blue black and red but these splen lid colours are exhibited only dur ing the pairing eason The female does not possess even a ru liment of this appendage In the *Anolis cristatellus* according to Mr Aus ten the throat pouch which is bright red marbled with yellow is present in the female though in a ru limental condition Again in certain other lizar ls both sexes are equally well provided with throat pouches Here we see with species belonging to tl e same group as in so many previous cases the same character either confined to the males or more largely developed in them than in the female or again equally developed in both sexes The little lizards of the genus Draco which glide through the air on their rib supported paracl ute and wl ich in the beauty of their col urs baffle description are furnished with skinny append ages to the tl roat like the wattles of gallina ceous birds These become erected when the

[66] Stol ka, J rnal f the Asiatic Society f B gal, ol. 18 0 p 166

an mal is ted Th y occ r l tl se es, b t e best d l ped wl tl r le r s t m t ty t wl h ag tl e n lll pe d g somt m s tw c as l g as tl l ad Most f tl pec lk se l e a l crest unn g alo g tl ck and tl much m re d l ped tl e f ll g o n mal s th n tl f mal r yo g mal s.

A Ch se pec s s sa d to l v pai dur g th pri g d tl o e s caught tl tl falls from th tre to tl e g d an l all tself to b pt ed w th mpunity —I p es m from d pai





Fi 34 *Ceratophor stodd rt* Uppe figure, mal l figur f mal

sc o d pe es f tl sam g t rm l sc l f rms mun t h rn th m t f tl fl ble ppend g d tl d j (*C stodd t* fig 34) tl wl l ppendag con ted t to l rn wh l lly l l t col b t as m p j l l t t l tl mm l s ted I tl ad lt m l f tl l t *te pc* th h rn h lf l l gtl b t t is l quite mm te n th f m l and tl y g. Tl se ppe dag as D Gu th has m ked to m may b comp ed th th comb f g ll aceo b d l f p tly serv as rn m t

In tl e g n Chamæleon we co ne t tl e acme f l l en tl e se Fl e upp r j (f g 3) d ced into tw g t so co ed with scal lk tl e r t f tl e l ad an l f tl s w l f l r odif t f tru t e tl f male hib ts ly ru l t Aga n *Cham le ow* (f g 36) fr m tl e w t oa t f Afr a tl male l r l t a l f l ad tl ee u s l rn f wl h tl e f m le l as ot a trace Tl se l n co s t f r see ce f bo co re l w th a smooth sl e tl f rn g p rt f tl g r l t gum t ts f tl l ly so tl t tl y d t al struct re w tl tl se f l ll g t otl r l tl l r d *rum* a t Altl ugl tl e tl e l d ff r so n l a ppe r nce from tl tw great j l g ti f tl k ll in C *b f rcu* we l rdly d l t tl t tl y serv the same g r l p rpose tl e eco my of tl se t o an ls l l e f rst o jecture wl cl will occur to ry that tl y are used by tl l s f r figl t g t g tl r an l as th se als re j uar lso tl p prol l ly co rect w M F W Wood also f ms m tl t l e ce watcl ed two d d l f *C p m lus* f gl ti g l tly tl b l f tree tl y fl g tl r l ads abo t d t ed to b t acl tl er tl y tl n ted f a t me ar d afterward co ti u d tl b ttl

W th m j l rd tl e se es d ff r l gl tly col u tl t ts d tripes f tl m l s b g b igl t nd m d t tly d f l tl tl f m l Tl f nsta tl e case tl tl bo Co j l t l w tl tl *A thodact l pe us* f S Af a. In a C ly l s f tl l tt r c t y tl n le is th m b dde g er tl tl f le I th I l *C l t s n gril bris* tl ere t ll g t d ff tl l p lso f tl m l black l l t th f tl fem l are gree I mm l ttl j f rd (*Z tora p*) tl l d f tl body d base f tl t l the m l b gl t ge pot ted w tl black tl f m l tl p rt re p l g j l g w tl t pot W h tl t tl l l l S tan po ss a tl t p l d tl pl d dly ti ted th bl black, d ed In th *I tot t s te us* f Cl l tl m le al e r m rked w tl

M S nhoe, *P oc Zoolog Soc* 1870 p 240

J D B hh l *M natsbericht k P Ak d* 1874 p 78

B ll *H tory f British Reptil* 2 d ed 1849 p 40

... es of a peculiar structure with serrated edges and when this snake is excited these scales are rubbed against each other which produces a curious prolonged almost hissing sound [63] With respect to the rattling of the rattle snake we have at last some definite information for Professor Aughey states [64] that on two occasions being himself unseen he wat...

... at last he saw another snake approach and when they met they paired Hence he is satisfied that one of the uses of the rattle is to bring the sexes together Unfortunately he did not ascertain whether it was the male or the female which remained stationary and called for the other But it by no means follows from the above fact that the rattle may not be of use to snakes in other ways as a warning to animals which would otherwise attack them Nor can I quite disbelieve the several accounts which have appeared of their thus paralysing their prey with fear Some other snakes also make a distinct noise by rapidly vibrating their tails against the surrounding stalks of plants and I have myself heard this in the case of a Trigonocephalus in S America

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... eir eyes glisten with rage and after waving their tails from side to side for a few seconds as if to gather energy they dart at each other furiously rolling over and over and holding firmly with their teeth The conflict generally ends in one of the combatants losing his tail which is often devoured by the victor The male of this species is considerably larger than the female [65] and this as far as Dr Günther has been able to ascertain is the general rule with lizards of all kinds The male alone of the *Cyrtodactylus rubidus* of the Andaman Islands possesses pre anal pores and these pores judging from analogy probably serve to emit an odour [66]

The sexes often differ greatly in various external characters The male of the above mentioned Anolis is furnished with a crest which runs along the back and tail and can be erected at pleasure but of this crest the female does not exhibit a trace In the Indian *Cophotis ceylanica* the female has a dorsal crest though much less developed than in the male and so it is as Dr Günther informs me, with the females of many iguanas chameleons and other lizards In some species however the crest is equally developed in both sexes as in the *Iguana tuberculata* In th...



FIG 33 *S... na...* M... le with the gular p... uch e... pa... ded (f... m Günth... r *R... pt... l... s... f... Ind... a*)

fan and is coloured blue black and red but these splendid colours are exhibited only dur... e does not ... endage In ... Mr Austen the throat pouch which is bright red marbled with yellow is present in the female though in a rudimental condition Again in certain other lizards both sexes are equally well provided with throat pouches Here we see with species belonging to the same group as in so many previous cases the same character either confined to the males or more largely developed in them than in the female or again equally developed in both sexes The little lizards of the genus Draco which glide through the air on their rib supported parachute and which in the beauty of their colours baffle description are furnished with skinny appendages to the throat like the wattles of gallinaceous birds. These become erected when the

[63] Dr Anderson *Proc Zool g Soc* 1871 p 196

[64] The *American Nat r l t* 1873 p 85

[65] Mr N L Austen k pt th se ... n m ls l ... f ... c ... de ... bl time see *Land ... nd W ... ter* July 1867 p 9

[66] St... l... ka, *Journal of the Asiatic Society of B... gal*, L... xxxi 1870 p 166

CHAPTER XIII

SECONDARY SEXUAL CHARACTERS OF BIRDS

structure t an any tl lass of animals. I shall, th ref re tre t the bject t co d r ab le gth Mal b rd som tim s, th gh rarel possess pecial we pons f fi hting th ach th Th y charm the f mal by ocal or nstrum tal mus f tl mo t aried kind Th y are rnam nted by ll sort f combs, w ttles, prot berances, h rns, ai -distended sacks, top-kn ts, naked shafts, pl mes and l gtl ed f th rs graceful lly pringing from all parts f tl body Th beak and naked skin abo t th head d th f th rs, are ft n g geo ly col ured The mal som times pay th co t by dancing, by fantastic antics perf rmed th th ground r in th ai I nstance at l ast, th mal mits a musk od ur whi h may suppose serves t harm ct th f mal f that cel lent bsers M Ramsay say f th A s-tralian musk-duck (*Bi ra lobat*) tl t tl e m ll h h th mal m t during th mm mo ths is confi d to th t sex, and in som indi iduals retai ed thro gl t th y ar I ha e n th breed g season, sh t femal h h had any m ll f musk. So po rful this od d ring th pairing seaso th t t can be d tected l g bef re th b rd can be see O th wl le, b rd ppear to be th m t asth t f ll animals, cept-ing f co rse man and tl y ha nearly th sar tast f th be tif l as ha This sh w h y m t f th g g f b rds, and by m both dised and sa g decki g th h ad w th borrowed pl mes, and sing g ms which are hardly m re brilliantl oloured than tl naked kin and ttle f ce tain b rds I man, h w i ltı ted, th sense f bea ty s mani festl far more omp l feeling, and asso-iated th arı t llect al ideas.

Bef re tre t g f th se al chara t w th h h re h m re part larly co ce ed, I m y just all I t certain d ff rence be t e th sexes hich ppare tly d pe d

dif reence in th r hab ts f lif f such cases, though commo n the l w are rare i the high r classes. Two l mm g birds bel g g I r J t t hanus, whi l nhab t tl

as t

f mal of th sam pecies, and th y d ff r sl gl tly the f rm of th beak. In anoth r g f l mm g b rd (Gryp) th beak of tl male is serr ted along tl margin and hooked at th extrem ty th us l ff ri g much from that f tl f male In tl Neom rpl f N w Zealand th re is, as w ha seen a till wid d ff re e th f rm f th beak in rela t n to the mann r f feeding f th tw se s Som thin of th sam kind l as bee obser ed w th the g ldf h (*Carduel s lcg*) f r I m ass red by M J J nn W that tl bird catch rs can dist guish the mal s by their l ghtly l g beaks. Tl flocks of m les are ften f und feeding on tl seed of the teazle (D psacu) wh cl tl y can ach w th th ir l ted beaks, whil t the f mal m re com m ly feed n the seed f th beto y or Scro-ph laria. W th sl gl t diff ren e f this kind as a f undati we can see h w tl beaks f th two se es migl t be mad to differ gre tly thro gh natural selecti In some f the abo cases, h w t is possibl th t the be ks f the mal may ha e been first mod fied lat t th o t ts w th th males and that this aft rward led to l ghtly changed hab ts f lif

Law f B ttle — Almo t all mal birds are trem ly p gnaci s, us g th ir be ks wings and l g f fighting tog tl r We see this ry pring w th o rob ns and par row Tl small t f all b rds, nan ly tl h mming b d is f th m t q rrelsom M Gosse[4] d scribe b ttl wl h pair seized h ld f ach th beaks, and whi led round and ro nd till th y alm t f ll to tl gro nd and M M tes d Oca, in pe king o an tl g f h mm g-b rd say th t tw mal ar ly meet w th t a fi rce aerial n co nte wl k pt eag th ir fighting has

Ibis I (series) 1867 p 414.

Gould, *H ndbook f the B ds f Aust alia*, 1865 ol ii, p. 383.

[4] Q ted by Mr G uld, *Introd ction to th T o-chilid* 1861 pag 29



FIG 35 *Chamæleo b f rcus* Upper figure m le l er f gure f male.

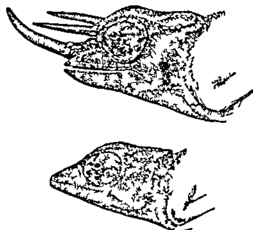


FIG 36 *Cl m l o w* Upp f g ure m le l er f g e f l

spot of blue green an l coppery red[7] In many cases the males retain the same colours througl out the year but in otl rs tl ey be come much brighter during the breedi g sea son I *Calotes* red head t e rest of bo y

Both sexes of many species are beautifully coloured exactly alike and there is no reason to suppose that such colours are protective No doubt with the bright green kinds which live in the midst of vegetation this colour serves to conce l them and in N l atagonia I saw a lizard (*I roctotretus multimaculatus*) wl ich when frightened flattened its body closed its eyes and then from its mottl l tints was hardly di tinguishable from the surroun li g sand But tl e bright colours with wl ich so many lizards are ornamented as well as their vario s curious appendages, were probal ly acquired by the males as n attraction and then transmitted eitl er to their male off pring or to l oth sexes Sexual selection indeed seems to have played alm st as important a part with reptiles as with l irds ai l the less conspicuous colours of the f ales in comp ar i on with the males cannot be accounted for as Mr Wallace believes to be tl e case with birds, by tl e greater e po ure of the females to danger luring incul ation

[7] F Beagl of S \ dre Calotes, r p 143

[7]-Gü th r I oc g Zoolog l Society 18 0, p 7"8 w tl l red l g re

snapping with th ir hu e beaks and gi ing heavy bl w with th ir wing Male sn pe fight h t r g and pushing ach other

hens are f llo ed by n half d z n i tn ir

(Bizur) and th male C nclo mphus cru at (all ed to ur p p ts) ar by m asurem t actu all t ice as large as th ir re pect f mal s. W th many th bird th f mal are larg r than th male and as f rm ly rema ked th planat ft n gi n, nam ly that th f males h m t f th w k in feeding th r g, ill t ffice I som f w cases, as w shall h realt see th f mal ppare tly ha acquired th ir gre te and t n th f th sak f co q ri g th f mal and obtaining possess f th males

Th mal f many g ll naceo birds, s pec ally f th poly g m kind f rn hed w th pecial weapons f fighting w th th ir ri als, nam ly sp rs, which can b used with f arful ffect It has bee ecorded by trustw rthy write that in D rby hire Lite stru k t gam h n accompanied by h chickens, when th cock ru hed to th esc e, and dro his pur right thro gh th y and skull f th ggresso Th spur was w th diffi cult dr wn from th kull d as th kite, th gh d ad, retai ed his g a p th tw birds w re firml locked tog th but th cock wh n dise tangled was ry little inj red Th in incibl courag f th g m -cock n tori us g tl man wh l g g w t ssed th brutal

sce b th p wo ld co tinu fight g Thi was nee u the pot, and the b rd f ught w th und unted courag u til h recei ed his d ath troke In C l sely all ed w ld spec es, th *Gallus*

part dg (*Ortygornis g laris*) the ma wh ch is f rni hed w th tro g and sharp p rs, is so quarrelsom that the scars of f rme fights disfigure the breast of almo t ry b rd y u kill

The male of alm t all gallinaceous birds, e n th se h ch are not f rn sl ed w th purs gag d ri g the breed g season in fi rce co fl ts. Th caperca l and l lack-cock (*T t ao u gall s* and *T tetri*) wl cl re both poly g mists, ha regular ppointed places, wh d ing many weeks th y co reg te n n mbers to fight t g th and to di play th r cha ms bef re th femal s. Dr W ko ale ky inf rms m th t in R ssi h has seen the s w ll bloody n the ar nas wl e the caperca l ie h f ght and th black-cocks mak the f tl rs fly in ery d rect n wh n sev ral g g n a battl royal Th ld r Brehm gi es a curi acco t f th *bal*, as th l dance and lo so g f th l lack-cock are called n G rm Th b rd tt rs almo t co tin usly th trang t n se he h lds l is tail p and preads t t l k a fan, l lifts p his h ad and neck w th ll th f tl rs rect, and t t h s h w gs from tl body Then h tak a f w j mp in d ff rent directi ns som tim rel and p sses the und part f hi beak so hard ainst the gro nd that th chin feath rs ar rubbed off D ri g th se m m nts l be ts his w g and turn round and ro nd Th m re ard t h grow th m re l ly h becomes, u t l t last tl bird ppe l k frant re ture. At ch tim th black-cock ar so bso bed th t th y becom almost bli d and d af h t l ss so than th cape ca lzi h cee b rd aft b rd may b h t n th sam spot, n ca ght by the ha d Afte perf rm g th se t es th mal b gin to fight and th sam black-cock, in rd to pro his st gth er se ral antag nists, will is t in th course f

R. Sch mburgk, in *J rnal f Royal Geog phic Society* l. xiii. 1843, p 31

Ornithological Biog phy l. i., p. 191. F peli cans and nipes, see l. iii., pp. 138, 477

G uld, *H ndbook of Birds of Aust alia*, vol. i., p. 395 l. ii., p. 383

M Hew tt, in th *Poultry Book*, by T getmeier 1866 p. 137

Layard, *A nals nd M gazine f Nat al History* l. xi 1854 p 63

Jerd n, *B ds f India*, l. iii., p. 574

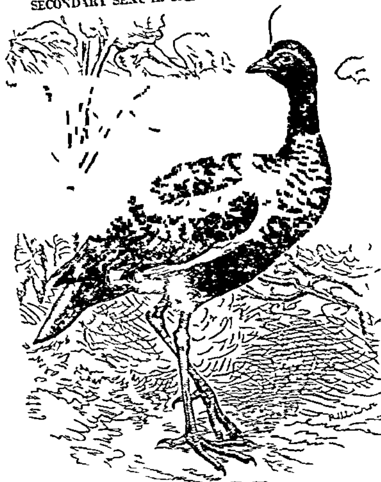
mostly ended in the splitting of the tongue of one of the two which then surely dies from being unable to feed [4] With waders the males of the common water hen (*Gallinula chloropus*) when pairing fight violently for the females they stand nearly upright in the water and strike with their feet Two were seen to be thus engaged for half an hour until one got hold of the head of the other which would have been killed had not the observer interfered the female all the time looking on as a quiet spectator [5] Mr Blyth informs me that day at a particular spot where the females propose to lay their eggs The fowlers discover these spots by the turf being trampled somewhat bare Here they fight very much like game-cocks seizing each other with their beaks and striking with their wings The great ruff of feathers round the neck is then erected and according to Col Montagu sweeps the ground as a shield to defend the more tender parts and thus is the only instance known to me in the case of birds of any structure serving as a shield The ruff of feathers however from its



Fig 37 The Ruff or *Machetes pugnax* (from Brehm *Thierleben*)

the males of an allied bird (*Gallicrex cristatus*) are a third larger than the females and are so pugnacious during the breeding season that they are kept by the natives of eastern Bengal for the sake of fighting Various other birds are kept in India for the same purpose for instance the bulbuls (*Pycnonotus hæmorrhous*) which fight with great ... ar fig ... y and ... erably larger than the females congregate day after varied and rich colour probably serves in chief part as an ornament Like most pugnacious birds they seem always ready to fight and when closely confined often kill each other but Montagu observed that their pugnacity becomes greater during the spring when the long feathers on their necks are fully developed and at this period the least movement by any one bird provokes a general battle [7] Of the pugnacity of web footed b ... s ... k-duck (*Cairina moschata*) and where these fights have occurred the river is

[4] Gould *ibid* p 52.
[5] W Thompson *Nat al Hist y of Ireland Birds* vol i 1850 p 327
[6] Jerdon *Birds of India* 1863 vol p 96
[7] Macgillivray *History of British Birds* vol iv 1852, pp 17 181



F G. 38 *Pa.am dea cornuta* (from Brehm), hewing the double wing-spurs and the filament on the head.

i..g to Audubon, se ral males of the Vir ginian goat suck (*C primulgus vi gianus*) court, in highly tertaining mann the female and no sooner has she mad her choice than he pproved gi es chase to all intrud rs and dri es th m be ond his d minions. G nerall the males try to dri w or kill their ri als before they pair It does not, how er ppear that th females in ariabl pref the ictorious males. I ha indeed been assured b D W ho al sk that the female caper cailzie sometimes steals w y with youn male who has not dared to enter the arena with the lder cocks, in the sam mann as occasionally happens w th the does of the red deer in Scotland. When two males contend in presence of a single f male, the victor no doubt, commonl gains his desire b t some of these battle are caused by wand rin males tryin to distract th peace of an already

...

the male f such males are g n rally decorated with arious ornam nts, which often becom more brilliant during the breeding season, and which are sedulously displa ed before th f males. Th males also end ur to charm excit their mates by lo e-notes, songs, and antics and the courtship is, in man

Ornithological Biography vol. p. 275.

Brehm, *Thierleben, &c.*, B 1867 p. 990. Audubon, *Ornithological Biography*, vol. ii., p. 492.

morning several bal. places which remain the same during successive years [14]

The peacock with his long train appears more like a dandy than a warrior but he sometimes engages in fierce contests the Rev W Darwin Fox informs me that at some little distance from Chester two peacocks became so excited whilst fighting that they flew over the whole city still engaged until they alighted on the top of St John s tower

The spur in those gallinaceous birds which are thus provided is generally single but Polyplectron (see fig 51 p 472) has two or more on each leg and one of the blood pheasants (*Ithaginis cruentus*) has been seen with five spurs The spurs are generally confined to the male, being represented by mere knobs or rudiments in the female but the females of the Java peacock (*Pavo muticus*) and as I am informed by Mr Blyth of the small fire backed pheasant (*Euplocamus erythropthalmus*) possess spurs In Galloperdix it is usual for the males to have two spurs and for the females to have only one on each l [15] spurs may ure which ransferred

Like most other secondary sexual characters the spurs are highly variable both in number and development in the same species

Various birds have spurs on their wings But the Egyptian goose (Chen

oped in other species In the spur winged goose *Plectropterus gambensis* the males have much larger spurs than the females and they use them as I am informed by Mr Bartlett in fighting together so that, in this case the wing spurs serve as sexual weapons but according to Livingstone they are chiefly used in the defence of the young The Palamedea (fig 38) is armed with a pair of spurs on each wing and these are such formidable weapons that a single blow has been known to drive a dog howling away But it does not appear that the spurs in this case or in that of some of the spur winged rails are larger in the male than in the female [16] In certain plovers however the wing spurs must be considered as a sexual character Thus in the male of our common peewit (*Vanellus cristatus*) the tubercle on the shoulder of the wing becomes more prominent during the breeding season and the males fight together In some species of Lobivanellus a similar tubercle becomes developed during the breeding season into a short horny spur In the Australian *L lobatus* both sexes hav ce are al s

gether in the same manner as our peewits by turning suddenly in the air and striking sideways at each other sometimes with fatal results Thus also they drive away other enemies [17]

The season of love is that of battle but the males of some birds as of th

presence of the female is the *teterrima belli causa* The Bengali baboos make the pretty little males of the amadavat (*Estrelda amandava*) fight together by placing three small cages in a row with a female in the middle after a little time the two males are turned loose and immediately a desperate battle ensues [19] When many males congregate at the same appointed spot and fight together as in the case of grouse and various other birds, they are generally attended by the females [20] which afterwards pair with

Brehm *Illu t Thie l ben,* 1867 B v s. 351 S n of the f regoing tat m nts are t k n from L. Lloyd *Game B rds f Sweden,* d 156 p 9

J don, *B ds of Ind* n Ithaginis, v l. i i. p 523 on G lloperdi x p 541

[16] For the Egyptian goose ee M gill vray *B itish B rds* ol iv p 639 F r Plectropt us, *L v g stone s T vels* p 254 F Palamed Br h n *Ill trierles Th erl ben,* B iv 40 See also o th s bird Azar *Voy g d ns l Améria mérid t m* 1809 pp 179 253

See n ur pe w t, Mr R C rr *La d nd Wate* A g 8 1868 p 46 In g rd t Lob llus, J d , *B d f Ind* v l 647 d G uld *H ndbook f B d f Aus l* v l p 220 F r th H pl pterus ce Mr All n in the *Ibis* v l. 1863 p 156

A dub *O thologi al B og phy* ol. i p 492 vol pp 4-13

[19] Mr Blyth *Land nd W ter* 1867 p 212.

[20] R ch rdson n *Tet ao mbell F na bor A er B d* 1831 p 343 l ll d C

t e t t k-cocks l t tl is cept n t th co rul p lly th h y l h ld n n th urr l g t h s, as is k n t b the case w th th grey h vca dn a, nd th th r peci N t n

It is certain that there is an intense degree of rivalry between the males in their singing. Bird-fanciers match their birds to see which will sing longest and I was told by Mr Yarrell t ... b rd will som times sing till h

... during the season ... of singing is sometimes quit ind pend nt of love is clear for a terile h brid canary b rd has been described as singin whilst viewing itself in mirror and th n dashing t its own image t ll k wise ttacked with fury f mal canary when put into th same cage Th jealousy excited b the act of singin is constantly taken ad antag of b bird-catch rs male in good song is hidd n and protected, ... stuffed bird urrounded b limed twigs, is xposed to vi w In this manne as Mr Weir informs me a man has in th course of single da ca ght fifty and in one instance, sevent male chaffinches. Th pow and inclination to sing diff so greatl with birds that although th price of an rdinary male chaffinch is nl sixpence M Weir saw one bird for which th bird-catcher asked three pounds the test of reall good singe being that t will continue t sing whilst th ca is swung round th wn head.

That male birds should sing from mulation as w ll as for charming th f mal is not t all incompatible and t might have been xpected that these t hab ts w uld ha e concurred, like those of displa and p gnacity Som u thors, how argue that the song of th male cannot serv t charm th f male, because th females of som f w pecies, such as of th canary robin, lark, and bullfinch, especiall when in stat of wid whood, as Bechst in remarks, pour f th fairl m lodi us strains. In some of these cases th hab t of singing may be in part ttrib ted t th f males ha ing bee highl fed and confi ed[22] f thus disturbs all th functions connected with the reproduction of th species. Many instances ha alread been gi en of the partial transference of secondary masculin charact rs to the female so that t is not at all urprising that th f males of some speci should possess the power of song. It has also been argued, that the song of the male cannot serve as a charm, because th males of certai pecies, for instance of th rob n, si g duri g th autumn.[23] B t n thi g more common than for animals to take pleasure in practi ing what in t t th follow at oth t mes f r som real good H w oft n do w see b rds which fly ... gliding and sailing thro g th ai ob iousl fo pleasure Th cat pla with th captured mo se and the cormorant w th th captured fish The wea r bird (Ploceus) whe confined n a cage amuses tself b eat[ly] w ... blades of grass bet een th wires f ts cage B rd wh h hab tuall fight duri g the breeding season are generally read t fight t all times and the males of th capercailzi sometimes hold th ir Balzen leks t th usual place of assembla ... d rin th autumn.[24] Hence t is ot t all urprising that mal birds should contin singin f th ir own amusement aft r th season f co rtship is

As sh wn in pre ious chapt r singi g is to a certain xt t an art, and is much impro ed by practice Birds can be ta ght various tunes, and n th unmelodious sparrow has learnt t ... lik linn t. Th y acquire th so g of th ir fost parents,[25] and som times that of their n ghbours.[26] All th common so gsters belo to the Ord of Insessores, and their ocal organs are much more complex than those of most th r birds t t singular fact that some of the Insessores, such as ra vens, crows, and magp es, possess th proper pparatus,[27] though th y ne er sing, and do not naturall modulat th ir oices to any great xtent. Hunt asserts[28] that with the true songst rs th muscles of th larynx are tronge in th males than in the f males but with this slight ception there is no diff rence in th vocal organs of the two se es, although th males of most pecies sing so much bett and more contin usly than th f males.

It is remarkabl that only mall birds properly sing. The Australian genus Men ra, how ve must be excepted f th Menura al-

[22] ... Naturg. d. der Stubenvögel, 1840, s. 2... Mr Bold, Zoologist, 1843-44, p. 659
[23] D Barr ... ton, Philosophical Transactions, 1773, p. 262. Bechstein. Stubenvögel, 1840, s. 4.

... actions 1773, p. 262

instances a prolonged ... t

... ore probable that the females are excited either before or after the conflict by certain males and thus unconsciously prefer them In the case of *Tetrao umbellus* a good observer[23] goes so far as to believe that the battles of the male are all a sham performed to show themselves to the greatest advantage before the admiring females who assemble around for I have never been able to find a maimed hero and seldom more than a broken feather I shall have to recur to this subject, but I may here add that with the *Tetrao cupido* of the United States about a score of males assemble at a particular spot and strutting about make the whole air resound with their extraordinary noises At the first answer from a female the males begin to figh uriously and the weaker give way but then according to Audubon both the victors and vanquished earch for the female so that the females must either then exert a choice or the battle must be renewed So again with one of the field starlings of the United States (*Sturnella ludoviciana*) the males engage in fierce conflicts but at the sight of a female they all fly after her as if mad [4]

Vocal and instrumental music —With birds the voice serves to express various emotions such as distress fear anger triumph or mere happiness It is apparently sometimes used to excite terror as in the case of the hissing noise made by some nestling birds Audubon[25] relates that a night heron (*Ardea nycticorax* Linn) which he kept tame used to hide itself when a cat approached and then suddenly start up uttering one of the most frightful cries apparently enjoying the cat s alarm and flight The common domestic cock clucks to the hen and the hen to her chickens when a dainty morsel is found The hen when she has laid an egg repeats the ame note very often and concludes with the sixth above which she holds for a longer time [26] and thus she expresses her joy Some social birds pparently call to each other for ai l and as they fl t from tree to tree the flock is kept together by chirp answering chirp During the nocturnal migrations of geese and other water fowl, sonorous clangs from the van may be heard in the dark ness overhead answered by clang in the rear Certain cries serve as danger signals, which as the sportsman knows to l ...

c ... triumph over a defeated rival The true song however of most birds and vari us strange cries are chiefly uttered during the breeding eason an l serve as a charm r merely as a call note to the other sex.

Naturalists are much divided with re pect to the object of the singing of birds Few more careful observers ever lived than Montagu and he maintained that the males of song birds and of many others do not in general search for the female but on the contrary their busine s in the spring is to perch on some conspicuous spot breathing out their full and armorous notes, which by instinct, the female knows and repairs to the pot to choose her mate [27] Mr Jenner Weir informs me that this is certainly the case with the nightingale Bechstein who kept bird during his whole life asserts, that the female canary always chooses the best singer and that in a state of nature the female finch selects that male out of a hun lred whose notes please her mo t. [?] There can be no doubt that birds closely at tend to each other s song Mr Weir has told me of the case of a bullfinch which had been taught to p pe a German waltz and who was so good a performer that he cost ten guineas when this bird was first introduced ... to a room ...

t e greatest intere t to the new perform er Many naturali ts believe that the si gin of birds is almo t exclu ively the effect of rivalry an l emulation an l not for tl e sake of charm ing their mates This was the opinion of Daines Barrington and White of Selborne who both especially attended to this subject [?] Barring ton however admits that superiority in song gives to birds an amazing ascei dai cy over others as is vell kno n to bird-catchers.

14 ... p ly ... n Tet ao ... l ... p 219 ... p 601

[25] The H n Daines B rri gt ... *Philosophical Transactions* 1773 p. 252.

[27] *O ... ithological Dictionary* 1833 p 4 5

[?] ... 1840 s. 4 Mr H rr so W ... rally ... m t first ... bred n th sam room.

Philosophical T ... ns 1 3, p. 263. Wh t *Nat al Hist y of S lbo ne* 1825 ... p. 246.

throat pouch of the E ropean male bustard (Otis tarda) and of at l ast four th r species, does not, as was formerl supposed serv to hold w ter b t is connected with th utt ance during th breeding-season of a peculiar sound resembling oak. [43] A crow lik bird inhabit South Am rica (Cephalopterus ornatus, fig. 40) is called th umbrella-bird, from its immense top knot, formed of bare white quills surmounted by dark bl plumes, which t can les t into gre t dom less than 5 inches diam ter co ring th whol head Th b rd has on ts neck lo g, thin, cylindrical fles ppendage which is thickly clothed w th scale-lik bl feath rs. It probabl se es in part as an rnam t, b t likewise as resounding pparatus f Mr Bates found that t is connected w th an unusual d lopment of the trachea and vocal organs. It is dilated when th bird utters ts singularly deep, loud and long ustained flute note. The h ad-crest and neck-appendage are rudimentary in the f male.[44]

The vocal organs of arious w b-footed and wading birds are extraordinarily complex, and diff r t a certain tent in th two se es. In some cases the trach a is con oluted, like a French horn, and is deeply mbedded in th st rnum. In th w ld wan (C gnus ferus) t s more deeply embedded in th adult mal than in th adult f male or young male In the male M anse th nlarged porti of th trach a is furnished with an additional pair of muscles.[45] In n of the ducks, h w nam ly A as p nelata, the bo y nlargem t is nly a little more d loped in th mal than n th f male.[46] B t th m aning f these diff rences



FIG. 40 The Umbrella-bird or C phalopterus ornatus, male (from Brehm).

[43] The following papers ha been lately writt this subject Prof A. Newton, in the Ibis, 1862, p. 107 Dr Cullen, ibid., 1865, p. 145 Mr Flo er in Proc Zool Soc., 1865, p. 47 and D Murie in Proc Zool Soc., 1868, p. 4 1 1 this latter paper an excelle t figure is gi e of the male Australian bustard full displa th the sack dist nded. It is singular fact that the sack is not developed in all the males of the same species.

[44] Bates, The Naturalist on the Amazons, 1863, vol. ii., p. 284 Wallace, in Proceed gs Zoological Society 1850, p. 206. A new species, w th still larger neck appendage (C pendul ger), has lat ly been disco ered, see Ibis, vol. i., p. 457

[45] Bishop, in Todd Cyclopædia of Anatomy and Physiology vol. p. 1499.

[46] Prof. N ton, Proc. Zoolog Soc., 1871 p. 651.

berti which is about the size of a half grown turkey not only mocks other birds but its own whistle is exceedingly beautiful and varied The males congregate and form cor *roborying* places where they sing raising and spreading their tails like peacocks and drooping their wings [39] It is also remarkable that birds which sing well are rarely decorated with brilliant colours or otl r r

u

gu ucr bee eater roller hoopoe wood peckers &c utter harsh cries and the brilliant birds of the tropics are hardly ever songsters [40] Hence bright colours and the power of song seem to replace each other We can perceive that if the plumage did not vary in brightness, or if bright colours were dangerous to the species other means would be employed to charm the females and melody of voice offers one such means

In some birds the vocal o y)

o on each side of the neck and these are largely inflated when the male during the breeding season makes his curious hollow sound audible at a great distance Audubon proved that the sound was intimately connected with this apparatus (which reminds us of the air sacks on each side of the mouth of certain male frogs) for he found that the sound was much diminished when one of the sacks of a tame bird was pricked and when both were pricked it was altogether stopped The female has a somewhat similar though smaller naked space of skin on the neck but this is not capable of inflation [41] The male of another kind of grouse (*Tetrao urophasianus*) whilst courting the female has his bare yel low œsophagus inflated to a prodigious size fully half as large as the body and he then utters various grating deep hollow tones. With his neck feathers erect his wings lowered and buzzing on the ground and his long pointed tail spread out like a fan he displays a variety of grotesque attitudes The œsophagus of the female is not in any way remarkable [42]

It seems now well made out that the great

FIG 39 *Tet ao cupido* male (T W Wood)

[39] G uld *H ndbook f the B d f A st l* l 1865 pp 308-310 See lso M T W Wood n th *St dent* April 18 0 p 125

[40] See marks t th ffect in Gould *Int oduction to the T ochilidæ* 1861 p 22.

[41] *Th Sportsm n nd Nat alist n C nada*, by M j r W Ross K 1866 pp 144 146 Mr T W Wood gi th *St d nt* (Ap l 18 0 p 116) n e cell nt cc t f th tt tud a d h b ts f this b rd dur g t

[42] u a bon *bid.* v l v p 507

throat pou h f th E ropean mal bustard (*Otis tard*) and f t l ast f u tl r spec es, does ot, as was f rme ly upposed serve to h ld t b t s connected w th tl e utte ance dun g tl breed g season f a pecul ar sound resembling oak " A crow lik b rd in hab ting So th Am rica (*C p alopterus o natus* fig. 40) i called the umbrella bird from ts immense t p knot, f rmed of bar white quills m ted by d k bl plumes wh ch t can l ate into gr t d m o l ss than fi in h diam t co n g th wl l h ad Tl t rd has ts neck a l g thin, ylindri al fleshy ppend g which is thickly clothed th scal lik bl f th rs. It probably se part as an rnam t, but likese as resounding ppar tus f Mr B tes f und th t t is connected th an unusual d l pme t of the trachea and vocal organs It is d l ted wh n the b rd utt rs ts singul rly deep l d and l g s tau ed fluty n te The head-cr t and neck appe d g are rudim n tary in th femal "

The vocal organs of vario s web-footed and wad g b rds are xtraordi arily compl x and diffe t a certain e tent in th two se es. In som case the trach a is con oluted lik a



FIG. 40 Th Umbrella bird *C ph lopteru ornat* male (from Brehm)

F nch h rn and deeply mbedded in the

cles " In f th d ks, h w er n m ly *A as p t ta*, the b y nlarg m t is nly a littl m re d l ped in th mal th n n th f male." B t th m an g f these diff rences

"The f llo g papers ha bee lat ly wr tt th subject Prof A. Newton, th *Ibis* 1862, p 107 D Culle *ibid.*, 1865 p 145 M Flo Proc Zool. Soc 1865 p. 747 d D Murie in Proc Zool. oc 1868, p. 471 In this latt paper an cell t figure is gi of th mal Australia bustard f ll d play w th the sack d t ded It is gular fact that the sack is not d loped in all the males of the sam pecies.

Prof N wton, *P oc. Zoolog Soc.*, 1871 p 651.

in the trachea of the two sexes of the Anatidæ is not understood for the male is not always the more vociferous thus with the common duck the male hisses whilst the female utters a loud quack[47] In both sexes of one of the cranes (*Grus virgo*) the trachea penetrates the sternum but presents certain sexual modifi cations In the male of the black stork there is also a well marked sexual difference in the length and curvature of t[illegible]

[illegible]

[illegible] s and notes uttered by male birds during the breeding season serve as a charm or merely as a call to the female The soft cooing of the turtle dove and of many pigeons it may be presumed pleases the fe male When the femal of [illegible] ut [illegible] vers [illegible] oise [illegible] with erected feathers rustling wings and distended wattles he puffs and struts before her The *spel* of the black cock certainly serves as a call to the female for it has been known to bring four or five females from a distance to a male under confinement but as the black cock continues his *spel* for hours during successive days and in the case of the capercailzie with an agony of passion we are led to suppose that the females which are present are thus charmed[50] The voice of the common rook is known to alter during the breeding season and is therefore in some way sexual[51] But what shall we say about the harsh screams of for instance some kinds of macaws have these birds as bad taste for musical sounds as they apparently have for colour judging by the inharmonious contrast of their bright yellow and blue plumage It is indeed possible that without any advantage being thus gained the loud voices of many male birds may be the result of the inherited effects of the continued use of their vocal organs when excited by the strong passions of love jealousy and rage but to this point we shall recur when we treat of quadrupeds.

We have as yet spoken only of the voice but the males of various birds practise, during their courtship what may be called instru mental music Peacocks and birds of paradise rattle their quills together Turkey-cocks scrape their wings against the ground and some kinds of grouse thus produce a buzzing sound Another North American grouse, the *Tetrao umbellu* when with his tail erect, his ruffs displayed he shows off his finery to the females who he hid in the neighbourhood drums by rapidly striking his wings together above his back according to Mr R. Haymond and not, as Audubon thought, by strik ing them against his sides The sound thus produced is compared by some to distant thunder and by others to the quick roll of a drum The female never drums but flies directly to th place where the male is thus engaged The male of the Kalij pheasant, in the Himalayas, often makes a singular drumming noise with his wings not unlike the sound produced by shaking a stiff piece of cloth On the west coast of Africa the little black weavers (Ploceus) congregate in a small party on the bushes round a small open pace and sing and glide through the air with quivering wings, which make a rapid whirring sound like a child s rattle One bird after another thus performs for hours together but only during the courting season At this season and at no other time the males of certain night jars (Caprimulgus) make a strange booming noise with their wings The various species of wood peckers strike a sonorous branch with their beaks with so rapid a vibratory movement that the head appears to be in two places at once The sound thus produced is audible at a considerable distance but cannot be de scribed and I feel sure that its source would never be conjectured by any one hearing it for the first time As this jarring sound is made chiefly during the breeding season it has been considered as a love song but it is perhaps more strictly a love-call The female when driven from her nest has been observed thus to call her mate who answered in the same manner and soon appeared Lastly the male Hoopoe (*Upupa epops*) combines vocal and instrumental music for during the breeding season this bird as Mr Swinhoe observed first draws in air and then taps the end of its

[illegible] sent, o th t pe h ps th y re n w te d g t ards bort n

[48] *Element f C mpa at A t my* by R W g n r Eng translat. 1845 p 111 With re pect to th swan gi abo Y rrell *H to y f Brit h B d* 2 d ed t o 1845 v l. p 193

C L. Bon parte, qu ted in the *Nat alist Li b ary B d* v l. xi p 126

L. Ll yd *Th Gam B d f Sw den, &c* 1867 pp 22 81

[51] Jenner *Philosophical T nsact ns* 1824 p 20

beak perpend cularly down agai st sto e o the trunk I tree wl n tl b c tl be ng forced d n the t b lar b ll produce the cor rect sound. If th beak n t th s tru k against some bject, th so d i ut diff r t. Ar is t th sam t e all wed and tl e œsophagu th become m l sw ll n and th probably acts as a reso ato n t only th th hoopoe b t w th p geons and otl r birds.

In th f reg g cases so nd are mad by th aid of tru t already present and th rwise ecess y b t in tl e f ll g ase ce tain f th rs h e bee pec ally mod f ed f r the press p rpo f prod c ng sounds. The dr mming bl ti g n gling tl u le ing (as expressed by d ff re t bse) mad by th comm n sn pe (*Scolopax gal l g*) m th urprised e ery wl has h ard t. Tl b rd d i g tl pai g seaso fl t pe l p tl sand feet i h ght, and aft g zagg g bo t f r a t me desce d t th arth i urved l w th tspread tail and q g p n ns, and r p g loc ty Th so d i n tted nly d g th p d d sce t. No was abl t xplai the se until M M bse ed that ach side f th tail the t f tl r

Fig. 41 O t tail f th f *Scol pax gall g* (from *Proceed g Zoologic l Society* 1858)

th se f tl rs, by fast g th m t a l g

S rey f *Ind* p 227 A d b *Am ric*

1 k ise mak th p g cur us ise during ts rapid flight.

tl n st k and w i g tl em r p dly tl rough th air l e could reprod ce th dru ming n made by tl e h ng b rd B th se are f rnisl ed w tl tl se fe tl rs, but tl ey are g rally l rge in tl n ale than in th fem l and eu t a deeper n t In some peci s, as n *S f en ta* (fig 42) f ur feath rs, and in *S*

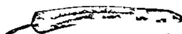


Fig 42 O t l lf th of *Scol pax f nata.*

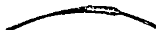


Fig 43 O t t ul f th of *Scol pax javensis.*

j ens s (fig 43) n l ss tl an gl t n eacl de of tl e tail re g e tly modif ed D ff rent t s re tt d b the fe ther of the l ff

In th mal f tl e *Chamæpetes un color* (a larg gall acco s b rd f Am ri a) tl e f rst prim ry w g f ther s arcl ed towards tl t p and is m ch m re tten ated than n the f mal I a ll ed b rd the l n l pen gra. Mr Sal n obse ed a mal wl h, wh l t (*Syph ot d ritus*) has its p u a y g f tl rs gre tly acun ted and tl e n al f an all ed peci i kn w i to make a h mm g ise wl l t cou ti g tl fem l [33] In w d ly d ff re t gro p f b rds, nan ly h m u g b rds, the m l alo e f ce ta n k nd ha th r th sl afts f th pri a y w g f th broadly d l ted or tl w bs abruptly ci ed to ard the extrem ty The mal fo n tance of *S lasphorus platyc s* when dult, has th fi t p mary w g f the (fig 44) th sed Whilst flying from fl to fl wer h m kes a sh ll alm t

[33] See M M t re t g p per P oc *Zool. Soc* 1858, p 199 F th h b ts f th pe M c gill y *H tory f Bri h B d* l p 371 F th Am ca pe, C pt. Bl k t *Ibi* l

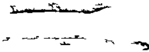


Fig 44 Prim ry wing feather of a humming bird the *Sel sphorus platycercus* (from a sketch by Mr Sal n) Upper figur th t of male lower figure corre p nding feather of fem le

whistling noise [16] but it did not appear to Mr Salvin that the noise was intentionally ma le

Lastly in several pecies of a sub genus of Pipra or manakin the males as described by Mr Sclater have their *secondary* wing feathers modified in a still more remarkable manner In the brilliantly-coloured *P deliciosa* the first three secondaries are thick stemmed and curved towards the body in the fourth and fifth (fig 45 *a*) the change is greater and in *the sixth and seventh (b c) the shaft is thick* ened to an extraordinary degree forming a solid horny lump The barbs also are greatly changed in shape in comparison with the cor responding feathers (*d e f*) in the female Even the bones of the wing which support these singular feathers in the male are said by Mr Fraser to be much thickened These little birds make an extraordinary noise the first sharp note being not unlike the crack of a whip [17]

The diversity of the sounds both vocal and instrumental made by the males of many birds during the breeding season and the di versity of the means for producing such sounds are highly remarkable We thus gain a high idea of their importance for sexual purposes and are reminded of the conclusion arrived at as to insects It is not difficult to imagine the steps by which the notes of a bird primarily used as a mere call or for some other purpose might have been improved into a melodious love one In the case of the modified feathers, by
noi
dur
then
females were led to select the best performers, the males wh ch possessed the strongest or thickest or most attenuated feathers situated on any part of the body would be the most successful and thus by slow degrees the feath ers might be modified to almost any extent The females of course would not notice each slight successive alteration in shape but only the sounds thus produced It is a curious fact that in the same class of animals, sounds so different as the drumming of the snipe s tail, the tapping of the woodpecker s beak, the harsh trumpet like cry of certain water fowl, the cooing of the turtle-dove and the song of

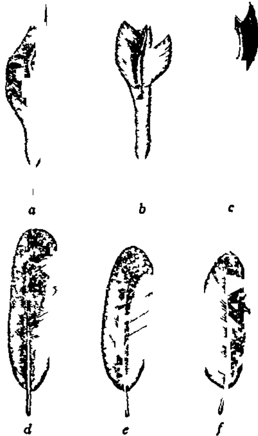


Fig 45 Second ry ng feathers f *P pra*

a d *d* fifth seco dary w g f tt r of l d f m le upp r surf c *b* d *e* t th second ry ppe rf ce a d *f* s ve th co d ry l r urf ce

the nightingale should all be pleas ng to the females of the several species But we must not judge of the tastes of di tinct pecies by a uni form stan lard nor must e ju lge by the stan lard of man s taste Even with man we should rem mber what discordant toises, the beating of tom toms and the shrill notes of

[16] Sa

[17] p 90 a d n *Ibis* v L iv z p in *Ibis* 1860 p 37

reeds, please the ars of savages. Sir S. Baker remarks, that as th stomach of the Arab prefers the raw m at and reeking h er taken hot from the animal, so does his ar prefe his equally coarse and discordant *music* to all other

Love Antics and Dances —Th curious love gestures of some birds ha e already been incidentally noticed so that little need h re be added. In N rthern America larg numbers of

we ha seen with th black African w a er instead of on the ground Durin th spri g our little wh te-throat (*Sylvia cinerea*) often r n n the air abo some

courting the f male as has been Wolf An allied Indian bustard (*Otis bengalen*



FIG. 46 Bower-bird, *Chl mydera maculata*, with bower (from Brehm).

grouse th *Tetrao phan nellus* meet ery morning during th breeding seaso on a selected le l spot, and h re th y run round and round in circl of about fiftee twenty feet in diamete so that th ground is worn q t bare like fairy ring. In these partridge-dances, as the are called by th hunters, th birds assum the strangest attitudes, and run round, some to th left and some to th ri ht. Audubon describes the males of h ro (*Ardea herodias*) as walking about n their long legs with great dignity bef re th f males, bidding defiance to their rivals. W th on f th disgusting carrion-vult res (*Cathartes jot*) th same naturalist states that the gesticulations and parade of th males t th beginnin of the lo e-seaso are xtrem l ludicrous." C rtain birds perform their lo e-antics th wing, as

sis) t uch times "rises perpend cularly into th air with a hurried flapping of his wings, raising his crest and puffing t th feath rs of his neck and breast, and then drops to the ground h repeats this manœuvre se eral times, t th sam tim humming in a peculiar ton Such f males as happen to be near "obey this saltatory summ ns, and when they p-proach he trails his wings and spreads his tail lik tu key-cock.[48]

B t th most curious case is aff rded by three allied g n ra of Australian birds, th

The Nile Tributaries of Abyssinia, 1867 p. 203.

[48] For *Tetrao phasianellus*, see Richardson, *F una, Bor Americana*, p. 361 and for further particulars Capt. Blakiston, *Ibis*, 1863, p. 125. For the Cathartes nd Ardea, Audubon, *Ornithological Biography* vol. ii., p. 51 nd vol. iii., p. 89. O th white-throat, M cgillivray *History of British Birds*, vol. ii., p. 354. O the Indian bustard, Jerdon, *Birds of India*, vol. iii., p. 618.

famous bower birds—no doubt the co-descendants of some ancient pecies which first acquired the strange instinct of constructing bowers for performing their love antics The bowers (fig 46) which shall hereafter s shells bones and for the sole of their nests are formed in trees Both sexes assist in the erection of the bowers but the male is the principal workman So strong is this instinct that it is practised under confinement and Mr Strange has described [9] the habits of some satin bower birds which he kept in an aviary in New South Wales At times the male will chase the female all over the aviary then go to the bower pick up a gay feather or a large leaf utter a curious kind of note set all his feathers erect, run round the bower and become so excited that his eyes appear ready to start from his head he continues opening first one wing then the other uttering a low whistling note and like the domestic cock seems to be picking up omething from the ground until at last the female goes gently towards him Captain Stokes has described the habits and play houses of another species the great bower bird which was een

in its mouth These curious creations formed solely as halls of assemblage where both sexes amuse them elves and pay their court must cost the birds much labor The bower for instance of the fawn breasted species is nearly four feet in length eighteen inches in height and is raised on a thick platform of sticks

Decoration—I will first discuss the cases in which the males are ornamented either exclusively or in a much higher degree than the females and in a succeeding chapter those in which both sexes are equally ornamented and finally the rare cases in which the female is somewhat more brightly coloured than the male As with the artificial ornaments used by savage and civili ed men so with the natural ornaments of birds the head is the chief eat of decoration [1] The ornaments, as mentioned at the commencement of this chapter are wonderfully diversified The plumes on the front or back of the head consist of variou ly shaped feathers sometimes capable of erection or expansion by which their beautiful colours are fully displayed Elegant ear tufts (see fig 39 *ante*) are occasionally present The head is sometimes covered with velvety down, as with the pheasant or is naked and vividly coloured The throat also is sometimes ornamented with a beard wattles or caruncles. Such appendages are generally brightly-coloured and no doubt serve as ornaments, though not always ornamental in our eyes for whilst the male is in the act of courting the female they often swell and assume vivid tints, as in the male turkey

on the throat and into two horns one on each side of lendil top- of the most held [62] The us) inflates neck and with its wings drooping and tail expanded makes quite a grand appearance [63] Even the iris of the eye is sometimes more brightly coloured in the male than in the female and this is frequently the case with the beak for instance in our common blackbird *In Buceros corrugatus* the whole beak and immense casque are coloured more con picuously in the male than in the female and the oblique grooves upon the sides of the lower mandible are peculiar to the male sex [64]

The head again often supports fleshy appendages filaments and solid protuberances. These if not common to both sexes are always confined to the males. The solid protuberances have been described in detail by Dr W Marshall [5] who shews that they are formed either of cancellated bone coated with skin or of dermal and other tissues With mammals true horns are always supported on the frontal bones but with birds various bones have been modified for this purpose and

gradations connecting these two extremes Hence as Dr Marshall justly re-

[9] Gould *Handbook to the Birds of Australia* pp 444 449 455 The bower birds may be seen in the Zoological Society's Gardens, Regent's Park.

[1] See remarks to this effect on the Feeling of Beauty among Animals, by Mr J Shaw in the 4th [illegible] No 1866 p 681

[61] See Dr Mur[illegible] with coloured figures in *Proc Zool Society* 18[illegible] p 730

[62] Mr M[illegible] 1862 p 339

[63] *La[illegible]* 1869 p 217

[64] 'Lbe[illegible] Sel[illegible] *Nederland.* [illegible] *Zoology* [illegible] 18[illegible]

carls, variations of the most different kinds as e served f th d lopm nt thro gh se ual selection of these ornam ntal ppe dages. Elongated feath rs o pl m pring from almost every part of th body Th f ath rs n the throat and breast are som times d l ped into beautiful ruff and collars. The tail f athers are freq entl increased in length as w



F G. 47 *Paradis papuana* (T W Wood)

see in th tail-co rts f th peacock, and in the tail tself f th Argus ph asant. W th th peacock th bo of tl ta l h been modified to support th l n tail-co rts.[60] Th bod of th Argus not larg than th t of f l y t th length from th nd f th beak t th tremity of th tail is n less than fi e feet three inches,[57] and th t of the beautifull ocellated seco dary wing f athers n arly three feet. In a small African night jar (*C s mctornis exillarius*) one of the primary w g feathers, during th breeding season, ttain a l ngth of tw nty six nches, whil t the l rd itself is only ten inches in length. In an th cl sely allied genus of night jars, th shafts of the lo gated wing feath ers are naked cept at the trem t where th re is a disc.[58] Again, in anoth r g nus of ht jars, the tail feath rs are n till more prod n usl de- loped. In g n ral th f th rs f th tail are more often lo ted than those f th wings, a an great lo gation of th l tt impedes fl ght. We thus see that in losely allied b rds rnaments of the sam kind ha e been gained by th males through the developm nt of w d ly diff rent feath rs.

It is a curious fact that the feath rs f species belo g g to v ry distin t gro ps ha been modified in almost exactl the sam peculiar mann r Thu the wing f athers in one f th abo m nt oned ni ht jars are bare along the shaft, and t minat in disc o are, as th are som times called poo r rack t shaped F athers f this kind occ in th tail f a mot m t (*F m m ta supercil aris*) of kin fish r finch, humming-bird, parrot, se ral Indian drongos (D crurus and Ed h s, in on of whi h th disc tand rtically) and in th tail f certain birds of paradise In these latte birds, sim lar f thers, bea tifully ocellated rnament th head as is likew se th case with som gallinaceous birds. In an Indian bustard (*Syp eotid ritus*) th feath rs f rming th ar tufts, which are about f ur inches in l ngth also terminate in discs.[59] It is a most singular

[60] D W Marshall, Uber d V g lschwanz, ibid., B Heft 2, 18 2.

[57] Jardine Naturalist Libr ry *Birds*, vol. xi p. 166

[58] Sclater in the *Ibis*, vol. vi., 1864, p. 114 Living tone, *Expedition to the Z mbesi* 1865 p. 66

[59] Jerd n, *Birds f India*, ol iii. p. 620

fact that the motmots as Mr Salvin has clearly shown [70] give to their tail feathers the racket shape by biting off the barbs and further that this continued mutilation has produced a certain amount of inherited effect

Again the barbs of the feathers in various widely-distinct birds are filamentous or plumose as with some herons ibises birds of paradise and Gallinaceæ In other cases the barbs disappear leaving the shafts bare from

dress comes to be admired by man so with birds a change of almost any kind in the structure or colouring of the feathers in the male appears to have been admired by the female The fact of the feathers in widely distinct groups having been modified in an analogous manner no doubt depends primarily on all the feathers having nearly the same structure and manner of development and consequently tending to vary in the same manner We often



Fig 48 *Loph* n o l m l d f mal (f m Br hn)

end to end and these in the tail of the *Paradisea apoda* attain a lenotl of l r

see a ten lency to analogous variability in the plumage of our lom stic breeds belonging to listinct peci s Tl us top-knots have appeared in several pecies In an extinct variety of the turkey tl e top knot con i ted of l are quills surmounted v itl plumes of down so tl at tl ey som wl at reseml led tl rack t l ped feath er al ove l cribed In certain l reed of tl e I geo i an l fowl tl e featl ers are plumose with some ten l n y in the shafts to be n ked In

P oceed gs Zool g al Soc ty 18 3 p 4 9

[70] Wall ce in *l nals nd M g* ... *f N t al Hist ry* ol x 1857 p 416 nd in *M l y Arcl pelago* vol ii 1869 p 390

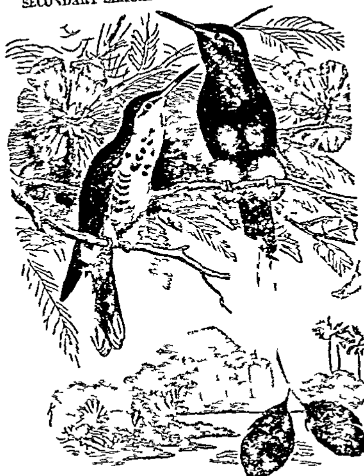


FIG. 49. *Spathura underwoodi*, male and female (from Brehm).

the Sebastopol goose th scapular feathers are greatl longated, curved, en spirally twisted, with the margins plumose.[7]

In regard to colour hardly anything need here be said, for ery ne know how splendid are the tints of man birds, and how harmoniousl they are combined. The colours are often metallic and iridesce t. Circular spots are sometimes surrounded by on more differ ently shaded zones, and are thus co erted into oce li. N need much be said on th w derful diff rence between the sexes of many birds. The common peacock offers a striking instance. Female birds of paradise are obscurely coloured and destitute of all ornaments, whilst the males are probably the most highly decor ated of all birds, and in so many different ways that they must be seen to be ppreciated. Th longated and g lden-orange plumes which spring from beneath th wings of the *Paradis a apoda*, when v rtically erected and mad to vibrate, are described as f rming a sort of halo, in the centre of which th head "looks like littl emerald sun with ts ray formed by the tw plumes."[8] In another most beautiful spe cies the head is bald, "and of a rich cobalt blue, crossed by several lines of black vel ty feathers."[9]

Male humming-birds (figs. 48 and 49) almost vie with birds of paradise in their bea ty

[7] See my work on *The V riation of A mals nd Plants nder Domestication*, vol. i., pp. 282, 283.

[8] Quoted from M. de Lafresnaye in *Annals nd M g of Natural History*, vol. xiii., 1854, p. 157: see also Mr. Wallace' much fuller account in vol. xx., 1857 p. 412, and his *The Malay Arch pelago*.

[9] Wallace, *The Malay Arch pelago*, ol. ii., 1869, p. 405.

fact that the motmots as Mr Salvin has clearly shown [73] give to their tail feathers the racket shape by biting off the barbs and further that this continued mutilation has produced a certain amount of inherited effect.

Again the barbs of the feathers in various widely-distinct birds are filamentous or plumose as with some herons ibises birds of paradise and Gallinaceæ In other cases the barbs disappear leaving the shafts bare from



FIG 48 *Loph o t* male | f male (f m Brehm)

end to end and these in the tail of the *Paradisea apoda* attain a length of thirty four inches [74] in *P Papuana* (fig 47) they are much shorter and thin Smaller feathers when thus denuded appear like bristles, as on the breast of the turkey-cock As any fleeting fashion in dress comes to be admired by man so with birds a change of almost any kind in the structure or colouring of the feathers in the male appears to have been admired by the female The fact of the feath

i .. g nearly the same structure and manner of development and consequently tending to vary in the same manner We often see a tend ncy to analogous variability in the plumage of our domestic breeds belonging to distinct speci s Thus top-knots have appeared in se eral p cies In an extinct variety of the turkey the top knot con ted f quills t they feath of the with

t nd ncy in the shafts to be n ked In

[73] *P oc d g Zoolog al Soc ty* 1873 p 429

[74] Wall ce in *A nals nd M gazine f Nat al History* vol xx 1857 p 416 nd in his *Mal y A ch pelago* vol ii 1869 p 390

to th m and t may p rl ps be attr buted to th d t a t o f tl e d fferent co liti ns to h ch the b rd n e p sed during the t o seaso s. Tl nally the e re m otl er b ds tl e se s f wh ch are l ke b t wl cl are d l d ffe t n ther n r nd winter pl m g F rthly tl ere a l ird tl e sex s f liich d ff f m ach th r i col ur b t th f mal s, th gh mo lti g t ce re tai the same c lo s thr ugl ut the y a hilst the mal s u de g l a ge f col u som tim s g t on as with t n bus-tard Iufthly d l stly tl e e a bird tl e se f h h d ff r f m h tl e n b tl th ir s mm and w t pl m g b t tle m l d goe a g t r m u t f cl ng t ach ce t easo tl tl f l — f l h th ruff (*Mach t s p g*) ff rs a good tan

W th p ct to th c e p rpo f tl e d ff e es l r b tw tl u r d t pl m g th s m y i m ta as th th pta ga rv d g b tl as p t t W l n tl d ff ce b t tl e t pl g l gl t t y i r hap l tt b ted lready m ked to the d rect act f th co d t s f l f B t w th m l d tl a h rdly b a d bt

tak s of tl e nature f tl e ex lu ively masculi e plum ge of many otl er birds

Fr m tl e foreg ng facts more e pecially f m n itl er s x f ce ta n birds chang ng col ou d i g e tl er ai i u l m lt or chang g so sligl tly tl t tl e cl nge ca hardly be of any i f the f males of tl r s r sp o tl n

assume n rnamental l arac u b eed ng seaso but th t tl double n o ilt hav ng been ig nally acquired f r some dis-ti t j urpose has s bsequently b en tak n l t g of in certain cases for gain i g a j t l plumage

It ppears at f r t igl t a surp is ng circum t c tl t some closely allied speci s sl uld r g l ly u de go a d ble annual m ult, and tl ers ly ngle e The ptarmig n fo t ce m lts tw ce r e en thrice n tl e nd th l lackcock ly nce som f tl pl n l lly col edl y ck rs(Nectar n) f I d a l some s b g n ra f obscu ely col ed p j ts (A tl u) l av a l bl l l t l nrl a n al mo lt. But ol tl w s l i

tl e ern l m lt f from compl t so f atl l g e ed and som cl anged n col u Tl lso eason t b li e tl t w tl ce t b ta ds nd l l k b rds, wh h p pe ly d g a do bl ult, som of th lde nal t n tl r n pti l plumage th gl t tl e y A f l ghly mod f ed f the m y n ely b added d r g tl e p g to the plum g a occurs tl the d sc f m d ta l f atl f tain dro g (Bhrı g) n I d a, l th the lo g t d f tl tl back neck d e est f ce ta n l By l t ps as th se the vern l

also kn n tl t fi t by ff t g tl r prod t y t m f m l b ds, f q tly

f d by M B tl tt th t gl t m pec m f th kn t (*Fr g t*) t d tl ad ed te pl m g the Zool g l G rd th o gh t th y f m l h fact y nf th t th nm pl m g tl gl mm t both se p

pe ed th l rd k t ff g tly f m b d f p y bef re t h acq red ts mm dress see W lh lm W ght, Ll y d *G m B d f S d* 1867 p 12.

435 d 444 d M St ff d All th *Ibis* l. 1863 p 33
O th m lt g f th pta m g see C ld *B d f G t B i n*. O th h y k J d *B ds f India*, l. pp 359 365 369 O th m ulti g of A thus se Blyth, in *Ibis* 1867 p 32

as every one will admit who has seen Mr Gould's splendid volume h collec ly differ Almost or their plumage has been taken advantage of and modified and the modifications have been carried as Mr Gould shewed me to a wonderful extreme in some species belonging to nearly every sub group Such cases are curiously like those which we see in our fancy breeds reared by man for the sake of ornament certain individuals originally varied in one character and other individuals of the same species in other characters and these have been seized and much f the fan the beak The sole between thes in the st of e more beautiful males

I will mention only one other bird remarkable from the extreme contrast in colour between the sexes namely the famous bell bird (*Chasmorhynchus niveus*) of S America, the note of which can be distinguished at the distance of nearly three miles and astonishes every one when first hearing it The male is pure white whilst the female is dusky green and white is a very rare colour in terrestrial species of moderate size and inoffensive habits The male also as described by Waterton has a spiral tube nearly three inches in length which rises from the base of the beak It is jet black dotted over with minute downy feathers This tube can be inflated with air through a communication with the palate and when not inflated hangs down on one side The genus consists of four species the males of which are very distinct whilst the females as described by Mr Sclater in a very interesting paper closely resemble each other thus offering an excellent instance of the co t

white with the exception of a large space of naked skin on the throat and round the eyes, which during the breeding season is of a fine green colour In a third species (*C tricarunculatus*) the head and neck alone of the male are white, the rest of the body being chestnut brown, and the male of this species is provided with three filamentous projections half as long as the body—one rising from the base of the beak and the two others from the corners of the mouth [5]

The coloured plumage and certain other ornaments of the adult males are either retained for life or are periodically renewed during the summer and breeding season. At this same season the beak and naked skin about the head frequently change colour as with some herons, ibises, gulls one of the bell birds just noticed &c. In the white ibis, the cheeks the inflatable skin of the throat and the basal portion of the beak then become crimson [6] In one of the rails, *Gallicrex cristatus* a large red caruncle is developed during this period on the head of the male So it is with a thin horny crest on the beak of one of the pelicans *P erythrorhynchus* for after the breeding season these horny crests are shed like horns from the heads of stags and the shore of an island in a lake in Nevada was found covered with these curious exuviæ [7]

Changes of col

margins being periodically shed or on these three processes more or less combined The shedding of the deciduary margins may be compared with the shedding of their down by very young birds for the down in most cases arises from the summits of the first true feathers [8]

With respect to the birds which annually undergo a double moult there are first some kinds for instance snipes swallows plovers (Glareola) and curlews in which the two sexes resemble each other and do not change colour at any season I do not know whether the winter plumage is thicker and warmer than the summer plumage but warmth seems the most probable end attained of a double moult where there is no change of colour Secondly there are birds for instance certain species of Totanus and other Grallatores the sexes of which resemble each other but in which the summer and winter plumage differ slightly in colour The difference however in these cases is so small that it can hardly be an advantage

[5] Mr Sclater *Intellectual Observer* Jan 1867 *Waterton's Wanderings* p 118 See also Mr Salvin's interesting paper with plate in the *Ibis* 1865 p 90

[6] *Land and Water* 1867 p 394

[7] Mr D G Elliot *Proc Zool Soc* 1869 p 589

[8] Nitzsch Pterylography edited by P L Sclater Ray Society 1867 p 14

to them and t may perh ps, be attrib ted to the direct acti n of th different co d ti ns to which th b rd are xposed during the two seasons. Thirdly th re are man otl e birds th sexes f hich are alike b t which are wid l diff re t in th ir umm and winte pluma,e. F rthly th re are b rds th sexes of hich diff from each the in col ur b t the f males, thou h m ulting twice, retain the same colours thro gh t th ar hilst the males und rgo a chang f col som times gre t as with certain bustards. Fifthly and lastly th re are b rds th sexes of which diff from each th r in both their umm and wint pl m b t th male ndergoes a great am unt of change t each recurre t season than th f mal — of hich the ruff (*Machete p g ax*) ff rs a good instance

W th respect to th cause r purpose f th differences in colour between th mme and winte pluma,e, this may in som inst ces, as with th ptarmigan, serv d ri g both seaso protection. Wh n th diff rence

that th umm plumag is rnam ntal, n whe both se es are alik W m co l d that this is th ase with many h rons, grets, &c., for th acq re th ir bea tiful plum nly d ring th breeding season. M reo such pl mes, top-kn ts, &c., th gh possessed by both se es, are occasi nally littl m re de loped in th mal than in th f mal and th resembl th plumes and rnam ts possessed b th males alon f ther birds. It is also kno n that confin m t, by affecting th reproducti tem f mal birds, freq ntl checks th d lopm t f th ir seco dary sexual charact rs, b t has n mmedi t in fl nce an th haract rs and I am f rmed b M *Bartlett that ei ht nine* specim ns of th kn t (*Tri g ca utus*) retained thei unad rned winte plumag in th Zoological Gard ns thro gh t th ear from which fact w ma nf that th umm pl mag tho gh comm n to both se es, par

[17]The brown mottled summer plumag of th ptarmigan is of as much importa ce t t as protection, as the hite te plumag for in Sca dina ia dur g the p g he the now has disappeared, this b rd is kn w t uffer greatly from b rds of prey before t has acquired ts ummer dress see Wilhelm vo W ht, Lloyd, *G me B rds of S den*, 1867 p. 125.

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slightly that the chang can hardly be service to them, and from th femal s f othe peci s moulting twice y t retaining the same col urs thro gh ut the y ar w may conclude th t th hab t f annuall moulting twice has n t been acquired rd r that the male h uld assume an ornam ntal character during the breedi g season b t that the d ubl m lt, ha ing been originally acquired for some distinct purpose has ubseq tly been taken ad antage f in certain cases for gaini g a n ptial pl mag

It ppears at first sight a surprising circum tance that som losely allied pecies should regularly und rgo a d ub annual moult, and l ngl Th ptarmigan, for

of India and som sub-g nera of obscurely col ed p p ts (Anthus) ha a do ble wl lst oth rs h nl a si gle annual m ult. But th grad t th manne of m ult g which are kn wn to occu w th various birds, sh w us h w pecies, r whol gro ps, might ha e riginally acquired their doubl ann al mo lt, ha ing o ce gai ed the hab t, h e gain lost t. W th certain bustard and plo rs the rnal mo lt is *far from compl te*, some feath rs being en wed and som changed n colour Th re also reason to belie that with certai bustards and rail lik birds, which prope ly und rgo a d bl m ult, some of th old r males retain thei ptial plumag thro gh t th year A f w highly modified f th rs may m rely be added duri g the pring to th pl mag as occurs with the disc f rmed tail feath rs of certain dro gos (*Bhri*) *in India*, and w th th lo gated feath rs n th back, neck, and crest f certain h rons. By ch tep as these, th v rnal

[18]In regard to th previous tat me ts moulting see, nipes, &c., Macgilli ray *Hist Brit. B ds*, l. p 3 1 Glareolæ curlews, nd bustards, Jerdon, *B ds of India* ol. iii., pp 615 630 683 on T ta us, *ibid*., p. 00 n the plumes of herons, *ibid* p. 738, d M cgilhvray ol. pp. 435 and 444 and M Staff rd Allen, in th *Ibis* l. 1863, p. 33

[19]On th moulti g f th ptarmigan, see Gould *B ds of G at B itain*. O the h ey-suck rs, J rd *Birds of India*, ol. i., pp. 359 365 369 O th m ulting of Anthus, see Blyth, in *Ibis* 1867 p 32.

moult might be rendered more and more complete until a perfect double moult was acquired. Some of the birds of paradise retain their nuptial feathers throughout the year, and thus have only a single moult; others cast them directly after the breeding season, and thus have a double moult; and others again cast them at this season during the first year, but not afterwards; so that these latter species are intermediate in their manner of moulting. There is also a great difference with many birds in the length of time during which the two annual plumages are retained; so that the one might come to be retained for the whole year, and the other completely lost. Thus in the spring *Machetes pugnax* retains his ruff for barely two months. In Natal the male widow-bird (*Chera progne*) acquires his fine plumage and long tail feathers in December or January, and loses them in March; so that they are retained only for about three months. Most species which undergo a double moult keep their ornamental feathers for about six months. The male, however, of the wild *Gallus bankiva* retains his neck-hackles for nine or ten months; and when these are cast off, the underlying black feathers on the neck are fully exposed to view. But with the domesticated descendant of this species, the neck-hackles of the male are immediately replaced by new ones; so that we here see, as to part of the plumage, a double moult changed under domestication into a single moult.[87]

The common drake (*Anas boschas*) after the breeding season is well known to lose his male plumage for a period of three months, during which time he assumes that of the female. The male pin-tail duck (*Anas acuta*) loses his plumage for the shorter period of six weeks or two

defiance to all human reasoning. But the believer in the gradual modification of species will be far from feeling surprise at finding gradations of all kinds. If the male pin-tail were to acquire his new plumage within a still shorter period, the new male feathers would almost necessarily be mingled with the old, and both with some proper to the female; and this apparently is the case with the male of a not distantly allied bird, namely the *Merganser serrator*, for the males are said to "undergo a change of plumage, which assimilates them in some measure to the female." By a little further acceleration in the process, the double moult would be completely lost.[88]

Some male birds, as before stated, become more brightly coloured in the spring, not by a vernal moult, but either by an actual change of colour in the feathers, or by their obscurely coloured deciduary margins being shed. Changes of colour thus caused may last for a longer or shorter time. In the *Pelecanus onocrotalus* a beautiful rosy tint, with lemon-coloured marks on the breast, overspreads the whole plumage in the spring; but these tints, as Mr. Sclater states, "do not last long, disappearing generally in about six weeks or two months after they have been attained." Certain finches shed the margins of their feathers in the spring, and then become brighter coloured, while other finches undergo no such change. Thus the *Fringilla tristis* of the United States (as well as many other American species) exhibits its bright colours only when the winter is past, whilst our goldfinch, which exactly represents this bird in habits, and our siskin, which represents it still more closely in structure, undergo no such annual change. But a difference of this kind in the plumage of allied species is not surprising, for with the common linnet, which belongs to the same family, the crimson forehead and breast are displayed only during the summer in England, whilst in Madeira these colours are retained throughout the year.[89]

Display by Male Birds of their Plumage.—Ornaments of all kinds, whether permanently or temporarily gained, are sedulously displayed by the males, and apparently serve to

[87] F r th e f re g tat e t n r g rd to p rt l ... h l o old m l s ret g th pl l

[88] See ... I p 34 ... w th ... Yarrell

[89] O ... 1868 p

O th V dua *Ibis* v L 18 p ... Dro osl r kes, J rd *bid* l i p 435 On the v al m lt f th *Herod* ... Mr S S All n n *Ibis* 1863 p 33 On *Gallus bankiva* Blyth ... *Annals and Mag of Natural History* ... 1848, p 45 ... see also on this subject my *Variation of Animals under Domestication*, vol. i. p. 236

Ornithological Biography ... pp ... Jerdon *Birds of India* ... 383 On the *Fringilla cannabina* of Madeira, Mr. E. Vernon Harcourt, *Ibis* vol. v. 1863 p 230

excite, attract, or fascinate the f males. B t th males will som times displa their orna ments, when not in the presence of the f males, as occasionally occurs with grouse at their balz-places, and as may be noticed with the peacock this latter bird, how ve evidently wishes for a spectato f some kind and as I ha often seen, will sh w ff his finery before poultry or n p gs.[48] All naturalists who have closely att nded to th hab ts f birds, whether in st te f n ture or under confinement, are unanimously of pinion that the males tak d light in displaying th ir beauty

them to th greatest advantage bef re th female D Jerd n[49] insists that th bea tiful pl mage of th male serves to fascin te and ttract th f male M Bartl tt, t th Zoological G strongest

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pea-fowl, the males displaying their gorgeous trains, and trutting about in all the pomp of pride before the gratified f males. The wild turkey-cock erects his gl ttering plumage ex pands his finely zoned tail and barred wing feathers, and altogeth r with his crimson and blu w ttles, makes s perb tho gh, to our ey grotesqu ppearance. Sim lar facts ha e already been g n with respect to grouse of various kinds. Turning to an oth Order The male *R picola crocea* (fig. 50) is one of the most beautiful birds in the world, being of a splendid or ange with some of th f athers curi usly truncated and plu mose Th female is brownish green, shaded with red and has a much maller crest. Sir R Schomburgk has described t courtship h f und one of their meeting places where ten males and two females were present. Th space was from f ur to fi e feet in diam ter and appeared to ha been cleared of ev ry blad f grass and smoothed as if by human hands. A male was capering, to the pparent delight of se eral thers. N w spreading ts wings, throwing p ts h ad, or pening ts ta l lik a fan now strutting about with a h pping gait until tired, wh n t gabbled som kind of n t and was reli ed by an the Thus three of th m uccessi ely took the field and then with self pprobation, withdrew to rest. The Indians, in rder to obtain their skins, wait at on f the meeting places till the birds are eag rly e gaged in dancing, and then are able to kill with th ir po so ed arrows f ur or fi males, o aft th th[50] W th birds f paradise d zen more full-plumaged males congregate in tree to hold dancin party as t is called b th nati es and here th fly abo t, raise th wings, el t their exquisite pl m s, and make th m vibrat and th whole tree seems, as M Wallace remarks, t be filled with w vin plumes. When thus engaged they



F G. 50 *R picol crocea*, male (T W Wood).

[48] See also *Ornamental P ultry* by Rev E S. Dix n, 1848, p. 8.

[49] *B ds f Ind* trod t ol. p xxiv th peacock, vol. iii. p. 507 See G uld *Int oduction to the Trochilidæ* 1861 pp. 15 and 111.

[50] *Journal f R. Geogr ph. Soc.*, vol. x., 1840, p. 236

become so absorbed that a skilful archer may shoot nearly the whol se birds ay Archi a keeping t atners clean often spreading them out examining them and removing every speck of dirt One observer who kept several pairs alive did not doubt that the display of the male was intended to please the female [58]

The gold and Amherst pheasants during their courtship not only expand and raise their splendid frills but twist them as I have myself seen obliquely towards the female on which ever side she may be standing obviously in order that a large surface may be displayed before her [59] They likewise turn their beautiful tails and tail coverts a little towards the same side Mr Bartlett has observed a male Polyplectron (fig 51) in the act of courtship and has shown me a specimen stuffed in the attitude then assumed The tail and wing feathers of this bird are ornamented with beautiful ocelli like those on the peacock s train Now when the peacock displays himself he expands and erects his tail transversely to his body for he stands in front of the female and has to shew off at the same time his rich blue throat and breast But the breast of the Polyplectron is obscurely coloured and the ocelli are not confined to the tail feathers. Consequently the Polyplectron does not stand in front of the female but he erects and expands his tail feathers a little obliquely lowering the expanded wing on the same side and raising that on the opposite side In this attitude the ocelli over the whole body are exposed at the same time before the eyes of the admiring female in one grand bespangled expanse To whichever side she may turn the expanded wings and the obliquely held tail are turned towards her The male tragopan pheasant acts in nearly the same manner for he raises the feathers of the body though not the wing itself on the side which



FIG 51 *P lyplect h q* male (T W Wood)

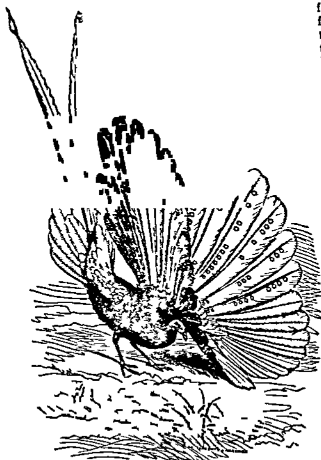
is opposite to the female and which would oth rwise be concealed so that nearly all the beautifully spotted feathers are exhibited at the same time

The Argus pheasant affords a much more remarkable case The immensely developed secondary wing feathers are confined to the male and each is ornamented with a row of from twenty to twenty three ocelli, above an

[58] *n ls nd Mag f Nat H t* vol xiii 1854 p 157 also Wallace *ibid* l x 1857 p 412 nd *Th Malay A h pel g* 9 p 292 Also m *Illustriert*

St dent April f d pl y pa se ph asa t *Ph erncolor* and h calls it th lat ral ne-sided display

spots of ar ... tiger and leopard combined. These beautif l ornam ts are hidd n til th mal sh ws himself ff bef re th f mal He th n erects hı tail, and expands his wing feathers into a great,



F a. 52 Sid view of male Argus ph asa t, whil t d playing bef re the f male Observed nd sk tched from ture by M T W Wood.

almost pright, circular fan sh ld wh ch ıs carried fro t f th body Th neck and h ad are h ld d so that th are co cealed b th fan b t th b rd ın d to see th f mal bef re wh m h ıs displ ying himself som t mes pushes his h ad betwee tw of th lo wı g f tl rs (as Mr Bartl tt has seen) and th prese ts a grotesq ppear ance. This must be freq t hab t with the bird n a state of nature for Mr Bartl tt and his son on examini g some perfect kins sent from the East, found a place bet een two of th feathers which was much fr ed as if the head had here frequ ntly been pushed through. M Wood thinks that the male can also peep at the f male on o e side be ond the marg n f the fan

Th ocelli on the wı g f ath rs are wond rful objects fo the re so shaded that, as th Duke f Argyll remarks,[60] th y tand o t like balls l ng loosely within sockets. Wh n I looked at the pecim n ın th Briti h Muse m which is m unted with tl wings ex panded and trailı g d wn wards, I was howe r greatly disappointed f the ocelli ap pea ed fl t, or n conca e. But Mr Gould soon made the case lear to me, f he held the f ath rs rect, ın the po ti n ın wh h they w uld nat rally be dı played and n w from th light sl ning on th m from abo each ocellus t ce re sembled th ornam nt called a ball and sock t. These f th rs h e been sh wn to se al art ts, and all ha e expressed th ir admirat at th perfect shading It m y w ll be asked, could ch artistically shaded rnam nts ha been f rmed by m ans f sex al select ? B t t will be con ni nt to d f gı ıng an answe to this q est n until w tre t ın th next ch pt f th principl f gradat n

Th f ing remarks late to th seco dary wing feathers, but th primary wing feath rs, which n mo t gallh aceous b rds are unif rmly colo red are in th Argus ph asa t equally w d rful. Th y are f soft brown tint with num rous dark pots, ach f which consi ts of two or three black d ts with rround g dark zo B t th chi f rnam t ıs a space parallel to the dark bl shaft, which ın o tl f rms a perfect seco d feath lying within th tru feath This ın part ıs col ured f a lighte

[60] *The Reig of Law* 1867 p 203

chestnut and is thickly dotted with minute white points I have shewn this feather to several persons and many have admired it even more than the ball and socket feathers and have declared that it was more like a work of art than of nature Now these feathers are quite hidden on all ordinary occasions but are fully displayed together with the long secondary feathers when they are all expanded together so as to form the great fan or shield

The case of the male Argus pheasant is eminently interesting because it affords good evidence that the most refined beauty may serve as a sexual charm and for no other purpose We must conclude that this is the case as the secondary and primary wing feathers are not at all displayed and the ball and socket ornaments are not exhibited in full perfection until the male assumes the attitude of courtship The Argus pheasant does not possess brilliant colours so that his success in love appears to depend on the great size of his plumes

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mals may deny that the female Argus pheasant can appreciate such refined beauty but he will then be compelled to admit that the extraordinary attitudes assumed by the male during the act of courtship by which the wonderful beauty of his plumage is fully displayed are purposeless and this is a conclusion which I for one will never admit

Although so many pheasants and allied gallinaceous birds carefully display their plumage b fo e the females it is remarkable as Mr

wallichii) so that these birds eem conscious that they ha e little beauty to display Mr Bart it has never seen the males of either of thes

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the Cheer as t

Weir also finds that all male birds ith rich or strongly-characterised plum ge are more quarrelsome than the dull-coloured pecies belonging to the same groups The goldfinch for instance is far more pugnacious than the linnet, and the blackbird than the thrush

Tho e birds which undergo a seasonal change of plumage likewise become much more pugnacious at the period when they are most gaily ornamented No doubt the males of some obscurely-coloured birds fight desperately together but it appears that when sexual selection has been highly influential and has given bright colours to the males of any species it has also very often given a strong tendency to pugnacity We shall meet with nearly analogous cases when we treat of mammals On the other hand with birds the power of song and brilliant colours have rarely been both acquired by the males of the same species but in this case the advantage gained would have been the same namely success in charming the female Nevertheless it must be owned that the males of several brilliantly coloured birds have had their feathers specially modified for the sake of producing instrumental music though the beauty of this cannot be compared at least according to our taste with that of the vocal music of many songsters

We will now turn to male birds which are not ornamented in any high degree but which nevertheless display during their courtship whatever attractions they may possess These cases are in some respects more curious than the foregoing and have been but little noticed I owe the following facts to Mr Weir who has long k

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of the female and then puffs out his breast so that many more of the crimson feathers are seen at once than otherwise would be the case At the same time he twists and bows his black

le in a ludicrous manner

bell as the ...

the same time b ing slightly expanded with the pure white bands on the shoulders thus render l con picu s The common linnet distends hi ro y l r ast lightly expands his brow i ings an l tail so as to make the best of them by exhibiting th ir white edgings We n u t howe er be cautious in concluding that

s r read out solely for display as

same time scraped on th gro nd The male gold-finch beha es differently from all other finches his wings are beautiful, the sh ulders being black, with th dark tipped wing feathers spotted w th white and edged with golden yellow When he courts the f male he sways his body from id to side and quickly turns his slightl expanded wings first to one side, then to the oth with a g lden flashing effect. Mr Weir inf rms m that no th British finch turns thus from sid to sid dur ng his courtship, not ev n the closel allied male siskin, for h would not thus add to his beauty

Most of the British buntings are plain col oured birds b t in th spring th feathers on the head of th mal reed-bunting (*Emberiza schoeniclus*) acquire a fin black colour by the abrasion of th dusky tips and these are erected during the act of courtship. M Weir has kept tw pecies of Amadina from Australia the *A. castanotis* is a ry small and chastely coloured finch, with dark tail, whit rump, and j t-black pper tail-co erts, each of the latter being marked with three large conspicuous val pots of white. This species, be courting th f mal slightly spreads out and ibrates these parti-coloured tail-co rt er pecul ar manner Th mal

colour and these, t might be thought could ne er be well exhib ted b t th bird when excited often spreads th m out laterall so that the can be see en from abo e. The crimson und tail-co rts of som th birds as with of th woodpeck rs, *P cus major* can be see without any such display The common pigeo has iridescent feathers on the breast, and ery ne must ha seen how the male inflates his breast whil t courting th f male, thus shewing them off to th best ad antage O of th beautiful bronze-winged pigeons of Australia *Ocyphaps lophote*) be haves, as escribed to m b M Weir very differentl th male whilst standing bef re the f male low rs h head almo t to th ground, spread out and raises his tail, and half expands his wings. H th n alternat ly and slowl aises and depresses his body so that the rid scent m tallic feathers are all seen at once and glitte in the sun.

Sufficient facts ha now been gi en to sh w with what care male b rds di play their various charms, and this th y do w th th utmost skill. Whil t preenin their f thers, the ha e frequent opportunit es f r admiring them sel es, and of tud ing how best to xhibit th ir beauty But as all the males of th same species display tl msel es in xactl the same manne t ppears that actions, at first pe haps intentional, ha e become instincti e If so, we ought not to accuse birds of conscious anit yet wh n we see a peacock trutt about, with expanded and quivering tail feathers, he seems th ry emblem of prid and vanity

Th arious ornaments possessed by th males are certainl of the highest importance to th m, f r in some ases th y ha e been ac quired at th expe se of gre tl impeded pow rs of fl ght or of running. The African night jar (Cosm tornis) which during th pai ing season has on of ts primary wing-feathers dev loped into a tream r of ry great l ngth, is th reby m ch retarded in ts flight, althoug t oth times remarkable f r ts swiftness. Th nwi ldy size of th secondary w feath rs of th male Argus pheasant i sa l almo t entirel to d pri th bird of flight. Th fi plumes f mal b rds of paradise ably do not suff mu h nco em nce searching for food from th ir impeded powers of mo em t b t th re can hardl be a doubt that th must be m ch more liable to be struck down b birds of prey can w d ubt that th long train of th peacock and th lo g tail and wi -feathers of th Argus ph asant mu t rend th m an easi pre to an prowling tige -cat than would otherwise be the case. E en th bright colours of many mal birds cannot fail t mak them con picu us t th ir nemies of all kinds. Hence as M Gould has remarked, t probably is that uch birds are generall of sh di position, as if conscious that their be uty was a source of danger and are much more difficult to discover o pproach, than th sombre coloured

For the descriptio of these birds, see Gould' *Handbook of the B rds of A stralia*, vol i., 1865, p. 41

Birds of India, ol ii., p. 96.

and comparatively tame females or than the young and as yet unadorned males [93]

It is a more curious fact that the males of some birds which are provided with special weapons for battle and which in a state of nature are so pugnacious that they often kill each other suffer from possessing certain ornaments Cock fighters trim the hackles and cut off the combs an l gill ... l the ... ibbed ... arful ... easy ... rsary s beak and as a cock always strikes where he holds when once he has seized his foe he has him entirely in his power Even supposing that the bird is not killed the loss of blood suffered by an undubbed cock is much greater than that sustained by one that has been trimmed [94] Young turkey-cocks in fighting always seize hol ...

... pected ... and wattles are not ornamental and cannot be of service to the birds in this way but even to our eyes the beauty of the glossy black Spanish cock is much enhanced by his white face and crimson comb and no one who has ever seen the splendid blue wattles of the male tragopan pheasant distended in courtship can for a moment doubt that beauty is the object gained From the foregoing facts we clearly see that the plumes and other ornaments of the males must be of the highest importance to them and we further see that beauty is even sometimes more important than success in battle

[93] On the Cosmetornis see Livingstone *Expedition to the Zambesi* ... pheas ... p 167 ... rel m ... B r ... vol ... Gould on the ... hyn s of m le bird *Handbook to Birds of Australia* vol i 1865 pp 210 ... 7

[94] Tegetmeier *The Poultry Book* 1866 p 139

CHAPTER XIV

BIRDS—C nt n ed

WHEN th sexes diff r in bea tv n th power of singing, n prod cing wl at I h called instrum tal mus it is alm t n ri abl th mal wh urpasses tl f male Tl se q alities, as w h e) t seen, re ıd tlv of I th mal When th y are I s

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tions, and oft perf rms t ang nt s ground in th air th presence f th fe r — l l aw \ r ıl h an,

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ttract in mai eq — — choice, and pref certain males This l tte que tio can be answ red in th affirm ti by much direct and direct d ce It is far more difficult to decid what qualities d t min th cho ce of th f males but h re gain w ha som direct and d rect d nce th t t is to larg xt nt th t rnal ttracti ns of the mal th gh d bt hı g ur cour ag and th m tal q al t es com int play W will begin tl th ind rect d ce

at t f pa g Thus in G rmany and Scandi

en m re l ird co greg t t th l ks and the sam place ft freq ted d ri g cessı ars Tl l k of th capercailzi last from th end f March t th middl n nd of M In N rth Am ri tl p tridg dance of th T t a phas nell la t f mo th more Oth kind f g se both in N rth Am ri and East rn S beria, f ll w

n a ly the same hab ts. The fowl rs d scover the h llocks wh re tl ruffs co gregat by th grass be ng trampled bare and thi hens tl at tl e sam pot is l g frequ nted Th Ind ans f Gu ana are well acq ainted w th the cl ared are as, where th y xpect to find th bea tiful cocks of the rock and the n ti e of New G in a kn w the trees where from ten to tw nty mal b rds of paradise in full plum g congreg t In this l tt r case it is n t ex pressl t ted that the f mal s meet n tl e sam trees, but the hunte s, if n t speciall asked w uld probably n t m nt n tl r pres- ce, as th r kins are l l ss. Small part of an African we (Ploceu) co gr gat d ring tl breed g season and perform f l urs th r graceful oluti ns. La g num l l ri pe (Scolopax m j) as-

running abo t like so many ats, puli tl f th rs, fl pping th ir wings, and utte ing th trang t ri s.

Som f th abo birds,—th black-cock, capercail ph asant grouse ruff solitary sn pe and pe h p others,—are as is bel e ed polygamists. W th ch b rds t m ght ha been th ght th t th stro g mal s w ld simply ha dri n w y th w ake and th n t ce h tak n possess n f as many fe- m l as poss l l but if t be indispensabl fo tl mal t cit pl ase th f mal w can und rstand the l gth f th co rtship and the co greg ti f so many ind vid als f both se es t th sam pot C rtain strictly mo- n gamo pec es lik wise h ld n pt al assem bla es thi seems t be th case in Scandina a

Nordman describes (*Bull. Soc. Imp. de Nat. Moscou*, 1861 tom. xxxı p. 264) th *balzen* of *Tet ogallod* in Amur La d. H estim ted th umbe f birds assembled t bo e hundred, t cou t g th f males, hich l h d the urround- g bu hes. Th ises ttered diff from those of *T ro ll*

1807 p. 412. O the sn pe Ll yd, *ou*. p

with one of the ptarmigans and their leks last from the middle of March to the middle of May In Australia the lyre bird (*Menura superba*) forms small round hillocks and the *M Alberti* scratches for itself shallow holes or as they are

y arge and an account has lately been published[3] by a traveller who heard in a valley beneath him thickly covered with scrub a din which completely astonished him on crawling onwards he beheld to his amazement abo t

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uring the breeding season and here the males meet and contend with each other for the favours of the female and here the latter assemble and coquet with the males With two of the genera the same bower is resorted to during many years

The common magpie (*Corvus pica* Linn) as I have been informed by the Rev W Darwin Fox used to assemble from all parts of Delamere Forest in order to celebrate the great magpie marriage Some years ago these birds abounded in extraordinary numbers so that a gamekeeper killed in one morning nineteen males and

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at particular spots where they could be seen in flocks chattering sometimes fighting bustling and flying about the trees The whole affair was evidently considered by the birds as one of the highest importance Shortly after the meeting they all separated and were then observed by Mr Fox and others to be paired for the ny district in n large num of cour e b ave different

habit in different countries For instance I have heard of only one instance from Mr Wedderburn of a regul r

t ce ed special names.

Unpaired Birds —From the fact n w given

we may conclude that the courtship of birds belonging to widely different group is often a prolonged delicate and troublesome affair There is even reason to suspect improbable as this will at first appear that some males and females of the same species, inhabiting the same district do not always please each other and consequently do not pair Many accounts have been published of either the male or female of a pair having been shot and quickly replaced by another This has been observed more frequently with the magpie than with any other bird owing perhaps to its conspicuous appearance and nest The illustrious Jenner states that in Wiltshire one of a pair was daily shot no less than seven times successively but all to no purpose for the remaining magpie soon found another mate and the last pair reared their young A new partner is generally found on the succeeding day but Mr Thompson gives the case of one being replaced on the evening of the same day Even after the eggs are hatched if one of the old birds is destroyed a mate will often be found this occurred after an interval of two days, in a case recently observed by one of Sir J Lubbock s keepers[4] The first and most obvious conjecture is that male magpies must be much more numerous than females and that in the above cases as well h

f gamekeepers in Delamere Forest assured Mr Fox that the magpies and carrion crows which they formerly killed in succession in large numbers near their nests, were all males and they accounted for this fact by the males being easily killed whilst bringing food to the sitting female Macgillivray however gives on the authority of an excellent observer an instance of three magpies successively killed on the same nest, which were all females and another case of six magpies successively killed whilst sitting on the same eggs, which renders it probable that most of them were female though as I hear from Mr Fox the male will sit on the eggs when the female is killed

Sir J Lubbock gamekeeper has repeatedly shot but how often he could not say one of a pair of jays (*Garrulus glandarius*) and has never failed shortly after wards to find th

3 Quoted by Mr T W Wood The Student April 1870 p 125

4 Gould Handbook of the Birds of Australia pp. 300 308 448 451 On the ptarmigan above alluded to see Lloyd ibid p 129

5 On Jenner Philosophical Transactions 1824 p 21 Macgillivray Hist Brit Birds Thompson Nat Hist of Ireland Mag Nat Hist 1842 p 494

survivor re-matched. Mr Fox, Mr F Bond, and others ha e shot o of a pair of carri n-crows (*Corvus corone*) b t th nest was soon again tenanted by a pai These b rd are rather commo b t th peregrine-falcon (*Falco peregri us*) is rare, y t M Thompson states that in Ireland if th an old mal r female be killed in the breeding season (not an uncommon circumstance) anoth rmat is f und uncommoncircumstance) anoth rmat isf und ... ithа erv f w d s, so that tl e rres, n t withstanding such casualties, are sure to turn out their compleme t of ung M J nn r Weir has known th same thing with th peregrine-falcons t Beachy H ad. Th same observer informs me that three kestrels (*Falco tinn unculus*) all males, w re killed on aft r the other hilst ttending th sam ne t two of these were in mature plumage but the third as in the plumage of the pre ous year E n with the rare gold eagl (*Aquila hry aëtos*) Mr B kbec was assured by a trustw rthy gamekeeper in Scotland, that if on killed, anothe is soon f und. So with th whit wl (*trix flamme*) the surv or readil f und a r gl l m sch f w t n.

th same d y Mr Engl heart also informs me that h used during se eral years to shoot one of a pair of starlings which built in a h le i a h use at Blackheath but tl e loss was alwa s immedi t ly repaired. During on season he kept an account, and found that he had sh t thirty five birds from the same nest th se con sisted of both males and females, b t in what proportion l could not say ne rth less, aft r all this destructi n, a brood was reared

These facts well deserve attention. H w s t that th re are b rds n gh ready to replace mmediat ly lost mate of e th r sex Mag p es, j y s, carrion-crows, partridges, and some other birds, are alwa seen during the pring in pairs, and n e by th msel es and these offer t first sight the most perplexing cases. B t birds of th sam sex, alth ugh of co rse n t trul paired som t mes h e in pa rs o in small parti s, as is known to be th case w th p geons and partridges. Birds also som times li n triplets, as has been bserved with n r

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parro s, which d p ed ... of their nests, to be shot but th which as left, the t cock hen, presentl procured mat and so f se ral times f llowing. I could add analogous cases relating t th chaf finch, nightingale and redstart. W th respect to the latt bird (*Phœnicura rut cill*) writ expresses much surprise h w th sitti g female could so soon ha gi n effectual notice that she was wid w f th species as not common in th neighbourhood. M Jenner Weir has mentio ed to m n arl similar case t Blackheath h n sees hears the not of th wild bullfinch, y t when one of his caged male has d ed wild on in the course of f w da has g rall come and perched ear th wid wed f male whose call-note is not loud I will gi nly o th fact on the thorit of this sam observ one of pair of starlings (*t rnus vulgaris*) was shot in the morning b noon new mat was found this was again shot, b t bef re night the pair was compl t so that the disconsolat widow or widower was thrice consoled durin

wid w or wid w r Th males of ce tain s ma occasi nall be h ard pouring f rth their l e-so g lo g afte th prope time, sh w ng that th ha e th lost r n gained a ma e. D ath from accid nt o disease of n of pair w uld l a the the free and ingle and there is reason to beli e that f m l birds during th breeding-season are especiall liable t prem ture d th. Again, bird which ha had their nests destroyed o barren pairs, retarded indi iduals, would asily be in d ced to d sert th ir mates, and w uld probably be glad to tak what share th y could f th pl asures and duties of rearing off p ing altho gh not th ir own. Such co ti nci

[40] the peregrine falcon, see Thompson, *Nat. Hist. of I d nd B d* vol. i., 1849, p. 39 O ls, sparrows, nd partridges, see White *N t. H st. of Selborne* ed. of 1825, ol. i., p. 139 O the Phœnicura, see *Loudon M g of Nat. Hist.*, vol. ii., 1834 p. 245 Brehm (*Thierleben*, B s. 991) also alludes t cases f birds thrice mated during the sam day See Whit (*Nat. Hist. of S lborne* 1825, ol. p. 140) the xist ce early the seaso of small coveys of male partridges, of which fact I ha e heard other in t ces. See J nner the retarded t t of the ge rat rgans certain birds, *Ph l. T nsact.*, 18 4 In regard t birds livi g in triplets, I owe t M J nn Weir the cases of the starli gs nd parrots, and t M Fox, of partrid es car rion-crows, see th *F ld* 1868, p. 415 O arious

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same district during the height of the breeding season there should be so many males and females always ready to repair the loss of a mated bird Why do not such spare birds immediately pair together? Have we not some reason to su pect, and the suspicion has occurred to Mr Jenner Weir that as the courtship of birds appears to be in many cases prolonged and tedious so it occasionally happens that certain males and females do not succeed during the proper season in exciting each other s love and consequently do not pair This suspicion will appear somewhat less improbable after we have seen what strong antipathies and preferences female birds occasionally evince towards particular males

Mental Qualities of Birds and their Taste for the Beautiful —Before we further discuss the question whether the females select the more attractive males or accept the first whom they may encounter it will be advisable briefly to consider the mental powers of birds Their reason is generally and perhaps justly ranked as low yet some facts coul l be given[9] leading to an opposite conclusion Low powers of reasoning however are compatible as we see with mankind with strong affections acute perception and a taste for the beautiful and it is with these latter qualities that we are here concerned It has often been said that parrots become so deeply attached to each other that when one lies the other pines for a long time but Mr Jenner Weir thinks that with most birds the strength of their affection has been much exaggerated Nevertheless when one of a pair in a state of nature has been shot the survivor has been heard for days afterwards uttering a plaintive call and Mr St. John gives various facts proving the attachment of mated birds[10] Mr Bennett relates[11] that in China after a drake of the beautiful mandarin teal had been stolen the duck remained disconsolate though sedulously courted by another mandarin drake who di played b fore her all his charms After an interval of three weeks the stolen drake was recovered and instantly the pair recogni ed each other with extreme joy On the other hand starlings, as we have seen may be consoled thrice in the same day for the loss of their mates. Pigeons have such excellent local memorie that they have been known to ret r

[illegible]

vould remain mated for life be separated for a few weeks during the winter and afterwards matched with other birds, the two when brought together again rarely if ever recogni e each other

Birds sometimes exhibit benevolent feelings they will feed the deserted young ones even of distinct pecies but this perhaps ought to be consi lered as a mi taken instinct They will feed as shewn in an earlier part of this work adult birds of their own pecies which have become blind Mr Buxton gives a curious account of a parrot which took care of a fro t bitten and crippled bird of a listinct pecies, cleansed her feathers and lefended her from the attacks of the other parrots which roamed freely about his garden It is a still more curious fact that the e birds apparently e ince some sympathy for the pl asures of their fellows When a pair of cockatoos made a nest in an acacia tree it was ridiculous to see the extravagant intere t tak n in the m tter by the others of the ame peci s Th e parrots, also evinced unbounded curiosity and clearly

n ale b rds singi g fter th proper pe iod see Rev L J nj s, *Ob t ons N t l H tory* 1846 p 87

[illegible] gs ct pped as a decoy to d tr y th ld es by [illegible] h t i ext d tl d y h h ks, our th t n k ll d nd th l ft tl est O retu g ft rw rd h f u d t o m re h r t bl ind d ls tl san e rn d f m rcy O of th se h k lled tl tl h ls h t, but co ld n t f id. [illegible] re cam th l ke f u tl ss rr t. I m d bted t l rof N wt n f r th f ll g passag from M [illegible] *f N t ist* nut hat l m re ld g od f tl n t ed h rd l l is. [illegible] the b rd was u bl t rn k tl h placed th m o by n n his t glass, l tly w th th u n that th y w ld t become ft r—an nt rest g proof f ntellig nce n th part of these b rds.

[10] *T S th l nd k* l i 1849 p. 18[illegible] Dr B ll r says (*B d f N r Z ol nd* 18[illegible], p [illegible]6) tl t l k ag l ry a k lled l th f m le fretted d ped refused h r food d d ed of brok l rt.

[11] *W nders g n New S th W ale* vol. 1834 p. 62.

had "the idea of property and possessi n. 12 They have good m mories, f n th Zoologi cal Gardens they ha plainly recognised the r former masters aft r an int rval f some months.

B ds possess acute pow rs f observ tion E ery mated bird, of course recognises its fe... And bon tates that ce tain number of mocking-thrushes (M mus polyglottus) re main all the year ro nd in Louisiana, whilst — t the East rn Stat these

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different persons, as is pro ed b th tro g and perman t ant path affection wh h ter sh w witho t pparent ca se to wards certa n indi iduals. I ha h ard of numerous instances w th ja s, partridges, an anes, and especially b llfinches. M Hussey has described in how traordinary mann tamed partrid recognised rybody and its likes and dislikes w re ry tron This bird seemed f nd of ga colours, and no n w gown or cap could be p t o with ut catching his atte tion. Mr H witt has described th habits of some d ks (rece tl descended from wild b ds) which, t th pproach of a strange dog or cat, w uld rush h adlong int th ater and xhaust th mselves th at tempts to escape but th kn w M H witt wn d gs and cats so w ll that th would h down and bask in th sun lose to th m Th y al mo ed way from trange man, and so they would from th lady wh tt nded them if s made an great hang in h dress. Aud bo relates that h reared and tamed wild turk which alw ran w from an strange d g this bird escaped into the woods, and some d aft rwards Audu bon saw as h tho ght, w ld turk and mad his d g chase t b t t his astonish ment, the b d did not run w and th dog, hen h cam p, did not ttack th bird, f the m tually recognised each th as ld friends.

M Jenne Wei is co vinced that birds pay particular tt tio to th colours of oth bird som times t f jealou and som times as n of kinship Th h t rned reed buntin (Emberiza schan culus) which had acquired ts black head-dress, nto his a ary and th newcomer was n t noticed by an bird cept by a bullfin h, whi h i like wise black h aded This bullfinch was a ry qui t bird, and had n er before quarrelled with any of its comrades, including another reed-bunting, whi h had not as t becom black headed but the reed-bunt ng w th a black h ad was so unmercif lly tre ted tl t it had to be remo ed Spiza yanea, d ring the breeding season, is of brigl t blue colo and tho gh gen rall peaceabl it attacked S n whi h has only the head blue and com pl t l scalped th unfortun te b rd Mr W r was also obl ged t turn out a robin, as it fi rcel ttacked all th birds in his a iary w th an red in th plumag but no other kind t actuall killed a red-breasted ross bill, and nearl killed a goldfinch. On th otl hand, l has observed that som b rds, wh n first introduced, fl toward th species wl ch resembl th m most in colou and settle by th sides.

A mal b rd displa tl ir fine plumag and oth ornam ts w th so mu h care bef re th f males, t is ob usl probable that these appreciat th beauty of th uitors. It s, h w difficult to obtain direct vidence f th ir c pacity to appreci t beauty Wh n b ... look g glass (of w ... c ...

... and admirat n. It pe haps th l rm tee ing which, as tated by Lord Lilf rd [13] ttra ts th ruff t w rd an bright object, so that, in th I ian I lands, t will dart d wn to a bright-coloured handk rc i f regardless of re peated sh ts. Th common lark is drawn d wn from th sky and caught in large numbers, b a small mirro mad to mo and glitter in th sun Is t admiration or curiosity wh h l ads th magp ra n, and som oth bird t teal and secret bright objects, uch as sil articles o j w ls

M G uld tates that certain humm g bird decorat th out ides of th ir nests with th utmost ta t th instin t l fast n thereo be utiful p eces of flat lich n, the larg p ece th middle and tl mall n th part ttached to th branch. N w and th n a prett feath is int rtwined o fastened

[10] Acclimatization of Parrots, by C Buxt n. M P A nals nd M g of Nat Hist., N 1868, p. 381

The Zoologist, 1847-48, p. 1602.

Hew tt ld ducks, J rnal of Horticu Jan 13, 1863, p. 39 Audubon on the ild tur ey Ornithological Biogr phy, vol i., p. 14 On the mock ing-thrush, ibid., vol i., p. 110.

[13] The Ibis vol ii., 1860, p. 344.

to the outer sides the stem being always so placed that the feather stands out beyond the surface The best evidence however of a taste for the beautiful is afforded by the three genera of Australian bower birds already mentioned Their bowers (see fig 46 p 463) where the sexes congregate and play strange antics are variously constructed but what most concerns us is that they are decorated by the several species in a different manner The satin bower bird collects gaily coloured articles such as the bl [illegible] s of par [illegible] which it [illegible] the en [illegible] r Gould found in one bower a neatly worked stone tomahawk and a slip of blue cotton evidently procured from a native encampment These objects are continually re arranged and carried about by the birds whilst at play The bower of the spotted bower bird is beautifully lined with tall grasses so disposed that the heads nearly meet and the decorations are very profuse Round stones are used to keep the grass stems in their proper places and to make divergent paths leading to the bower The stones and shells are often brought from a great distance The regent bird as described by Mr Ramsay ornaments its short bower with bleached land shells belonging to five or six species and with berries of various colours blue red and black which give it when fresh a very pretty appearance Besides these there were several newly picked leaves and young shoots of a pinkish colour the whole shewing a decided taste for the beautiful Well may Mr Gould say that these highly decorated halls of assembly must be regarded as the most wonderful instances of bird architecture yet discovered and the taste as we see of the several species certainly differs [16]

Preference for particular Males by the Females —Having made these preliminary remarks on the discrimination and taste of birds I will give all the facts known to me which bear on the preference shewn by the female for particular males It is certain that distinct species of birds occasionally pair in a state of nature and produce hybrids Many instances could be given thus Macgillivray relates how a male blackbird and female thrush fell in love with each other and produced offspring [17] Several years ago eighteen cases had been recorded of the occurrence in Great Britain of hybrids between the black grouse and pheasant [18] but most of these cases may perhaps be accounted for by solitary birds not finding one of their own species to pair with With other birds [illegible] reason [illegible] result [illegible] ing in [illegible] proximity B [illegible] which have become absolutely fascinated with each other although living with their own species Thus Waterton[19] states that out of a flock of twent [illegible] C [illegible] ey produced hybrid offspring A male wigeon (*Mareca penelope*) living with females of the same species has been known to pair with a pintail duck *Querquedula acuta* Lloyd describes the remarkable attachment between a shield drake (*Tadorna vulpanser*) and a common duck Many additional instances could be given and the Rev E S Dixon remarks that those who have kept many different species of geese together well know what unaccountable attachments they are frequently forming and that they are quite as likely to pair and rear young with individuals of a race (species) apparently the most alien to themselves as with their own stock

The Rev W D Fox informs me that he possessed at the same time a pair of Chinese geese (*Anser cygnoides*) and a common gander with three geese The two lots kept quite separate until the Chinese gander seduced one of the common geese to live with him. Moreover of the young birds hatched from the eggs of the common geese only four were pure the other eighteen proving hybrids so that the Chinese gander seems to have had prepotent charms over the common gander I will give only one other case Mr Hewitt states that a wild duck reared in captivity

[16] On the [illegible] m [illegible] d [illegible] t [illegible] k [illegible] nds Gould, *Intro*d [illegible] to the *Birds of Aus* 1861 p 19 On the bower birds, Gould *Handbook of the Birds of Australia* 1865 [illegible] pp 444 461 Ramsay [illegible] the *Ibis* 1867 p 456

[17] *Hist* of *British Birds* vol [illegible] p 92

[18] *Zoologist* 1853-1854 p 3946

[19] W [illegible] *Essays on Nat Hist* 2nd series, pp. 42 and 117 For the following statements see the [illegible] Loudon's *Mag of Nat Hist* vol ix p 616 [illegible] S [illegible] d [illegible] *Ad* [illegible] L [illegible] 1854 p 452 Dixon *Ornamental and Domestic Poultry* p 13 Hewitt in *Journal of Horticult* Jan 13 1863 p 40 Bechstein *Stubenvögel* 1840 s 230 Mr J Jenner Weir [illegible] t [illegible] g [illegible] n e a [illegible] lo us case [illegible] d [illegible] ks [illegible] species

after breeding a co pl of seasons with h r own mallard, at once shook h m off on my pairing male pintail n th wat It was evidentl a case of lo at first sight, fo sh swam about the new-come caressingl th ugh be peared evid tly alarmed and a erse to her vertures of affection. From that h ur she forgot her ld partn r Wint passed by and the next spring th pintail seemed to h e become con rt t h r blandishm nts, f th y nested and produced se n or ght y ung ones.

What the charm may h been n these several cases, be nd m re n lty we cann t ven co jecture. Colour how som times comes into play for in ord to raise hybrids from th siskin (*Fri gilla pi us*) and th canary t is much th best plan, according to Bechstein, to place birds of the sam tint together Mr. Jenn Weir turned a f male canary into his ary wh re th re were male linnets, goldfinches, siskins, greenfinches, chaffinches, and th birds, in rd to see which he w ld choose but there n was any doubt, and th greenfinch carried th day They paired and produced hybrid ff pring

The fact of th f mal pref rring to pair with ne male rather than with an th f th same species is n t so lik ly to ct ttention, as when this occurs, as w ha just seen, bet een distin t species. Th f rm cases can best be observed with d mesticated confined b rds b t these are ften pampered by high feeding, and som tim ha th ir instincts tiated t an xtrem degree Of this latter fact I could gi suffici nt proof with pigeons, and especiall with f wls, but th y cannot be here related V tiated instincts may also account f som f th hybrid uni ns abo mentioned but in many f these cases the birds w re allowed to range freely ver large ponds, and there is o reason t ppose that they w re nnaturally tim lated by high feeding

W th respect to birds in a tate of nature, the first and most obvious pposition which will occur to ry ne is that th f male t the proper season accepts th first male whom she may encounte but sh has t least th opportunity f ex rting choice, as h is almost in ariably p rs ed by man males. Audubo —and w must rem mbe that h spent long lif in pro ling about th f rests of the United States and observing th birds— does not doubt that th f male d liberat ly chooses her mate thus, peaking of a wood pecker h says th hen is followed by half-a-d zen g y su tors, who continue perf rmi g tran antics, u til a marked pref rence is sh wn fo one" Th f male of th red winged starli g (*Ag laus pho c us*) is lik w se p sued by se eral males, until, becoming fatigued she alights, rece es th ir addresses, and soon mak a cho ce. He describes also h w se ral male night jars repeatedly plunge thro h the air w th astonishing rapidity sud d nly turn ng and thus making a singular n se but no soon r has the f mal made her cho ce than the oth mal s are dri en awa " W th ne of th ultures (*Cathartes au*) of the United States, parties of e ght, ten, or more males and f males assembl on fallen logs, "exhib ting th trong t d ire to please m tually and after many caresses, each male leads off his partner on the wing Audu bon likewise carefully observed the wild flocks (*er canadensis*) and gi es

until an ...

had mad afte which, although th y remained to th any person could asily per ce that th w re careful t keep in pairs. I ha bserved also that the ld r th birds th short w re th preliminaries of th ir courtship. Th bach lors and old maids wh ther in regret, or n t caring to be disturbed by th bustle qui tly mo ed asid and lay d wn at ... r t [29] Many similar

ha learnt respecting ...

I h rece ed long l tters on this subject from Messrs. H tt and T g tm e and almost an essay from th late Mr Brent. It will be admitted by ry on that these gentl m n, so w ll known from their published w ks, are careful and xperi nced bserv rs. Th y d n t beli th t th f mal pref r certain males account of th beauty f th ir plumag b t som allowance must be mad f th artificial tate under wh ch these birds have long been kept. Mr T getm r is convinced that gamecock, th gh disfigured by being dubbed and w th h hackles trimmed

[29] Aud bo *Ornithological Biogr phy* vol. i., pp. 191, 349 vol. ii., pp. 42, 275 vol. ii., p. 2.

would be accepted as readily as a male retaining all his natural ornaments Mr Brent, however admits that the beauty of the male probably aids in exciting the female and her acquiescence is necessary Mr Hewitt is convinced that the union is by no means left to mere chance for the female almost invariably prefers the most vigorous defiant and mettlesome male hence it is almost useless as he remarks to attempt true breeding if a game cock in good health and condition runs the locality for almost every hen on leaving the roosting place will resort to the game cock even though that bird may not actually drive away the male of her own variety Under ordinary circumstances the males and females of the fowl seem to come to a mutual understanding by means of certain gestures described to me by Mr Brent. But hens will often avoid the officious attentions of young males Old hens and hens of a pugnacious disposition as the same writer informs me dislike strange males and will not yield until well beaten into compliance Ferguson however describes how a quarrelsome hen was subdued by the gentle courtship of a Shanghai cock [1]

There is reason to believe that pigeons of both sexes prefer pairing with birds of the same breed and dovecot pigeons dislike all the highly improved breeds [22] Mr Harrison Weir has lately heard from a trustworthy observer who keeps blue pigeons that these drive away all other coloured varieties such as white red and yellow and from another observer that a female dun carrier could not, after repeated trials be matched with a black male but immediately paired with a dun Again Mr Tegetmeier had a female blue turbit that obstinately refused to pair with two males of the same breed which were successively shut up with her for weeks but on being let out she would have immediately accepted the first blue dragon th ffered As n shut up very pale n Never theless as a general rule colour appears to have little influence on the pairing of pigeons. Mr Tegetmeier at my request stained some of his birds with magenta but they were not much noticed by the others

Female pigeons occasionally feel a strong antipathy towards certain males, without any assignable cause Thus MM Boitard and Corbie whose experience extended over f rty five years state *Quand une femelle éprouve de l'antipathie pour un male avec lequel on veut l accoupler malgré tous les feux de l amour malgré l alpiste et le chènevis dont on la nourrit pour augmenter son ardeur malgré un emprisonnement de six mois et meme d un an elle refuse constamment ses caresses les avances empressées les agaceries les tournoiemens les tendres roucoulemens rien ne peut lui plaire ni l emouvoir gonflée boudeuse blottie dans un coin de sa prison elle n en sort que pour boire et manger ou pour repousser avec une espéce de rage des caresses devenues trop pressantes* [23] On the other hand Mr Harrison Weir has himself observed and has heard from several breeders that a female pigeon will occasionally take a strong fancy for a particular male and will desert her own mate for him Some females according to another experienced observer Riedel are of a profligate disposition, and prefer almost any stranger to their own mate Some amorous males called by our English fanciers gay birds are so successful in their gallantries that as Mr H Weir informs me they must be shut up on account of the mischief which they cause

Wild turkeys in the United States, according to Audubon ometimes pay their addresses to the domesticated females, and are generally received by them with great pleasure So that these females apparently prefer the wild to their own males.[24]

Here is a more curious case Sir R. H ron during many years kept an account of the habits of the peafowl which he br d in large numbers He states that the hens have frequently great preference to a particular peafowl They were all so fond of an old pied cock, that one year when he was confined though still in view they were constantly assembled close to the tr llice walls of his prison and would not suffer a japanned peacock to touch them On his being let out in th autumn the old st of the hens in tantly courted him and was succes ful in he courtship Th next year h was shut up in a tal le and then the hen

Ra nd Price P lt y 1854 p 27
22 V ri tion f A imals nd Pl nts nder Domesticat n, vol ii. p. 103.

23 B t rd d C l Les P g ns (e 1824 p 12. I pe l u as (T ité d l'Hi lst Nat t m ii 1850 p 200) has h n self observed n arly similar f ts w th p geo is.

D T ben. h 1824 s. 60
25 O thological B og phy l p 13 See to th sa ffect D Bry nt, n Allen s Mammals nd B ds f Flo da p 344

all courted b s ri L.[25] This ri al was a j1 panned black ged peaco k, t o ey a m b a tiful bird than the c mm n kind

L ht nst in, wh was good bse r and had cell t ppo t tes f bs at n t the C pe of Good H p as ed Rudolph that the f male wid w b rd (*Ch ra progne*) diso n th male wh n r bb d f tl e l ng t il f th rs witl which h rn m nted d n g th b eding season I pres me that this bsen ti must l been mad n b rds und confin m t.[27] H re an a alo g us ase D Jaeg [28] d t r f th Zool gi cal G rd ns f V nna, tat th t mal f il ph asant wh had b n tri phant er all the males and was th accepted lo f th f mal s, had hi amental med t ly l

f assembl g and sol c t l s att nt on [30] W h seen that a tam wild-du k sed ced an unwill g p nt l d ak aft long cou t l ij Mr Bartl tt bel s that tl e Lopl pl l ke many th g ll naceou b d s n t r ll polygamous, but two f m le cann t be placed in tl e ame cage with a mal as tl e figl t so much t gether Tl e following i tance f lry s m e urprising as it r l t to bull finches, which u u lly p for l f M J nn r We ntrod ced a d ll-col u ed and ugly fe- l l i umedi t ly at

h w and tu ed t l u

In all d y case th m l i so age that l nt f m le and does n t as f a b t, as th l W tl d

portant colour is in th co tsl p f b rds, in M Boardman, w ll kn wn collecto and bsen f b rd fo many y ars n tl N rth rn United Stat has e n hi l g peri ce een an lb p red w th an th b rd y th has had pportuniti f b n g m albinos b l g t se l p ci [29] It ca hardly be m ntai ed th t alb n in tat f t re ncapabl f b eed ng as th y can b ai ed w th th g t t fac l ty d confi m nt It pp tl f th t w m t ttrib t th f t th t th y do n t p t th ject n by th mally col red m ades

ce t comi t

m l M H w tt con ceu t pl as t in ari bly p f s tl ld b rds H does n t pp ar to b in tl least infl h col h t m t p ci

F m l b rd n t ly t l but som f case th co rt th mal figl t t g th f l p sess S R H n tat th t w th p f wl th first ad an re al mad by tl f m l som thi g f th sam kind tak pla d g t A d bo tl tl ld f m l f tl wild t k y W th tl percail tl f m l fl t und tl mal hilst l parad g t f th plac

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l g tailed d k (*H ld gl cialı*) t i as b n remarked y M Ek tr m th t t f m l m cl m co ted than the re t F q tly deed n e anind dual unded by ght m us m l

[25] t ly ari ty Rud lphi, *Beit äg Anth pologie*, 1812, s. 184

[27] D D ru ische Theor nd h Stell g *Moral nd Rel gion* 1869 s. 9

[28] Th tat m is gi by M A. Le th Ad ms, h *Field nd For t R ld* 18?3 p. 76, nd ac- cords th b pe ice

[30] I gard t pe f l ee S R. H ro P oc. *Zool g Soc* 1835 p 54 d th R E S D n, O m ntal P ult y 1848 p 8 F th turk y Au- d l *bid.* p 4 F th cap rca lz Ll yd, *G me B d f S eden*, 1867 p 23

M H tt, q ted T g tm *P ltry Book* 1866 p 165

would be accepted as readily as a male retaining all his natural ornaments Mr Brent however admits that the beauty of the male probably aids in exciting the female and her acquiescence is necessary Mr Hewitt is convinced that the union is by no means left to mere chance for the female almost invariably prefers the most vigorous defiant and mettlesome male hence it is almost useless as he remarks to attempt true breeding if a game cock in good health and condition runs the locality for almost every hen on leaving the roosting place will resort to the game cock even though that bird may not actually drive away the male of her own variety Under ordinary circumstances the males and females of the fowl seem to come to a mutual understanding by means of certain gestures described to me by Mr Brent But hens will often avoid the officious attentions of young males Old hens and hens of a pugnacious disposition as the same writer informs me dislike strange males and will not yield until well beaten into compliance Ferguson however describes how a quarrelsome hen was subdued by the gentle courtship of a Shanghai cock[21]

There is reason to believe that pigeons of both sexes prefer pairing with birds of the same breed and dovecot pigeons dislike all the highly improved breeds[22] Mr Harrison Weir has lately heard from a trustworthy observer who keeps blue pigeons that these drive away all other coloured varieties such as white red and yellow and from another observer that a female dun carrier could not after repeated trials be matched with a black male but immediately paired with a dun Again Mr Tegetmeier had a female blue turbit that obstinately refused to pair with two males of the same breed which were successively shut up with her for weeks but on being let out she would have immediately accepted the first blue dragon th t ff As
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much noticed by the others

Female pigeons occasionally feel a strong antipathy towards certain males without any assignable cause Thus MM Boitard and Corbie whose experience extended over forty five years state *Quand une femelle éprouve de l antipathie pour un male avec lequel on veut l accoupler malgré tous les feux de l amour malgré l alpiste et le chênevis dont on la nourrit pour augmenter son ardeur malgré un emprisonnement de six mois et même d un an elle refuse constamment ses caresses les avances empressées les agaceries les tournoiemens les tendres roucoulemens rien ne peut lui plaire ni l emouvoir gonflée boudeuse blottie dans un coin de sa prison elle n en sort que pour boire et manger ou pour repousser avec une espèce de rage des caresses devenues trop pressantes*[23] On the other hand Mr Harrison Weir has himself observed and has heard from several breeders that a female pigeon will occasionally take a strong fancy for a particular male and will desert her own mate for him Some females according to another experienced observer Riedel[24] are of a profligate disposition, and prefer almost any stranger to their own mate Some amorous males called by our English fanciers gay birds are so successful in their gallantries that as Mr H Weir informs me they must be shut up on account of the mischief which they cause

Wild turkeys in the United States according to Audubon sometimes pay their addresses to the domesticated females and are generally received by them with great pleasure So that these females apparently prefer the wild to their own males[25]

Here is a more curious case Sir R. Heron during many years kept an account of the habits of the peafowl which he bred in large numbers He states that the hens have frequently great preference to a particular peafowl They were all so fond of an old pied cock, that one year when he was confined though still in view they were constantly assembled close to the trellice walls of his prison and would not suffer a japanned peacock to touch them On his being let out in the autumn the oldest of the hens instantly courted him and was successful in her courtship The next year he was shut up in a stable and then the hen

[21] *Ra e nd I ri e P lt y* 1854 p 27
[22] *I n f t mals nd Plants nder D m sti cat n,* l. ii. p. 103

[23] B ta d) ( ) *Le l g ns* (1824) 12 I per l us (T *lé d l Hé éd*) *l* tom ii. 1850 p 296) has l mself l served rly similar f cts th p geons
[24] *D T ben ucht* 1824 s 86
[25] *O thological B og phy* l. p 13 See to th sa ffect D Bry nt, in All n *M mmals nd B d f Fl d* p 344

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Indi dual diff rences b tween th m mber
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to occur under tate f nature. S dd n nd
strongly marked var t s ar rar t is also
doul d l wh th if b ficial th y w uld ft n
be preserved thro gh sel ct on a d t ansm tted
to cceeding ge r t ns[34] N e th l ss, t

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in th s o th foll wing cases. In the males
alone of on of the Aust al an p r ake ts the
th ghs n some are scarl t, in oth r grass-
g een. In an ther parrakeet of the same
country some ind viduals h the band
across th w ng-co erts b gl t yell w wh le in
th s th am part i t ged w th ed [35] In
the United States some f w of the mal s f the
scarl t ta g (*Tanagra ru bra*) ha a
be tif l tran v rse ba d of gl wi g ed on
th mall r wing-coverts but this variation
n h t rare so that its preser

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Th f llowing case s in some respects mo
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258 et q), hich has bee of m re use to m tha
y other Review I did t see how g eat the
hances ere gainst th preservati of ariati ns,
hether sl ght or tro gly pro unced, occurring
nly in gle indi iduals.

[34] *Int oductio to the T ochilida* p 102
G uld, *H ndbook f B d f A st alia* L ii,
pp 32 d 68.
[35] Aud bo *O ith logical Biogr phy* 1838, L
p 389
[36] Jerdon, *B d f India*, L p. 108 d M
Blyth, *Land nd Water* 1868, p 381

Whether this statement is credible I know not but the native sportsmen shoot these females in order to stuff them as decoys [2]

With respect to female birds feeling a preference for particular males we must bear in mind that we can judge of choice being exerted only by analogy If an inhabitant of another planet were to behold a number of young rustics at a fair courting a pretty girl and quarrelling about her like birds at one of their places of assemblage he would by the eagerness of the wooers to please her and to display their finery infer that she had the power of choice Now with birds the evidence stands thus they have acute powers of observation and they seem to have some taste for the beautiful both in colour and sound It is certain that the females occasionally exhibit from unknown causes the strongest antipathies and preferences for particular males When the sexes differ in colour or in other ornaments the males with rare exceptions are [illegible] more decorated [illegible] nly during the [illegible] y display their [illegible] rt their voices and perform strange antics in the presence of the females Even well armed males who it might be thought would altogether depend for success on the law of battle are in most cases highly ornamented and their ornaments have been acquired at the expense of some loss of power In other cases ornaments have been acquired at the cost of increased risk from birds and beasts of prey With various species many individuals of both sexes congregate at the same spot and their courtship is a prolonged affair There is even reason to suspect that the males and females within the same district do not always succeed in pleasing each other and pairing

What then are we to conclud [illegible]

[illegible] female exerts a choice and that she receives the addresses of the male who pleases her most [3] It is not probable that she consciously deliberates but [illegible] excited or attracted by the most beautiful or melodious, or gallant males Nor need it be supposed that the female studies each stripe or spot of colour that the peahen for instance admires each detail in the gorgeous train of the peacock—she is probably struck only by the general effect. Nevertheless after hearing how carefully the male Argus [illegible]

[illegible] again how the male goldfinch alternately displays his gold bespangled wings, we ought not to feel too sure that the female does not attend to each detail of beauty We can judge as already remarked of choice being exerted only from analogy and the mental powers of birds do not differ fundamentally from ours From these various considerations we may conclude that the pairing of birds is not left to chance but that those males, which are best able by their various charms to please or excite the female are under ordinary circumstances accepted If [illegible]

[illegible] habitual or even occasional preference by the female of the more attractive males would almost certainly lead to their modification and such modifications might in the course of time be augmented to almost any extent compatible with the existence of the species

[illegible] ection That domesticated birds have varied greatly their variations being inherited is certain That birds in a state of nature have been modified into distinct races is now universally admitted [4] Variations may be divided into two classes those which appear to our ignorance to arise spontaneously and those which are directly related to the surrounding conditions so that all or nearly all the individuals of the same species are similarly modified Cases of the latter kind have recently

[2] Quoted in Lloyd Game Birds of Sweden, p. 34

[4] According to Dr Blasius (Ibis [illegible] 1860 p. 297) there are 425 [illegible] birds which breed in Europe besides [illegible] frequently regarded [illegible] Of the latter Blasius thinks that [illegible]

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correlated with th t f th hackles n th neck
nd loins, as m y be seen by comparing th se
f th rs in th gold n and sil r spangled
P lish, th H dans, and Cre -cœur breeds.
I som natural pec s w may bse ex
actly th sam correlati n in th col urs of
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f l and th prin pl f corr lati n th

bases, there was n each feather a ymm t ical
cur ed zone of dark brown In som in tances
th haft of th f ather determines the dis-
tribut n of the tints thus with the body
f th rs of a m grel from the same black
Spanish cock and a sil e spangled P lish hen
the haft, tog th r with a narrow space on
each side, was greenish-black, and this was
u u ded by a regular zone of da k brown
edged with brownish white. In these case we
ha f thers symm trically shaded lik those
wl h gi e so much elegance to the plumage of
many natural peci s. I ha lso n ticed a
vari ty of th comm n p geon with th wing
bars symm trically zoned w th three bright
shad nst ad of b g mply black on a
slaty bl e gro nd as in the parent speci s.

In many gro ps of bird the plum ge is
diffe th sev ral species, yet
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all.
th p geon,
bars, tho gh th y may be col red red yellow
whit black, blu th e t of th plumage
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m e n cas in which certain m rks are
tained th gh col ured in a mann r alm t
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p ecisely th t part black which is wh te in th
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in nat al species I laced and p gled f wls
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abruptly defined b t a mo grel aised by
m from black Sp m h cock gl ssed with
green, and whit g m h n, all th feath rs
re greenish black, excepting towards th ir
tremit es, h ch w re y ll w i h whit b t
betwee th whit extremities nd th black

ne cock b tt rfly (Vanessa) Mr Trim n has

[6] Bechstein, *Nat geschichte Deutschlands*, B
179 s. 31, sub- ariety f th m nck
p geon.

this is now known to be an error[40] This case seems analogous to that lately given of albino birds not pairing from being rejected by their comrades

In various parts of the northern seas a remarkable variety of ... guillemot ... be out of ... estima ... presents this variation It is characterised[41] by a pure white ring round the eye with a curved narrow white line an inch and a half in length extending back from the ring This conspicuous character has caused the bird to be ranked by several ornithologists as a distinct species under the name of *U lacrymans* but it is now known to be merely a variety It often pairs with the common kind yet intermediate gradations have never been seen nor is this surprising for variations which appear suddenly are often as I have elsewhere shewn[42] transmitted either unaltered or not at all We thus see that two distinct forms of the same species may co-exist in the same district and we cannot doubt that if the one had possessed any advantage over the other it would soon have been multiplied to the exclusion of the latter If for instance the male pied ravens instead of being persecuted by their comrades had been highly attractive (like the above pied peacock) to the black female ravens their numbers would have rapidly increased And this would have been a case of sexual selection

With respect to the slight individual differences which are common in a greater or less degree to all the members of the same species we have every reason to believe that they are by far the most important for the work of selection Secondary sexual characters are eminently liable to vary both with animals in a state of nature and under domestication[43] There is also reason to believe as we have seen in our eighth chapter that ... ons are more ... e femal ex ... favourable ... racters thus ... to one sex or to both sexes depends as we shall see in the following chapter on the form of inheritance which prevails

It is sometimes difficult to form an opinion whether certain slight differences between the sexes of birds are simply the result of variability with sexually limited inheritance without the aid of sexual selection or whether they have been augmented through this latter process. I do not here refer to the many instances where the male displays splendid colours or other ornaments of which the female partakes to a slight degree for these are almost certainly due to characters primarily acquired by the male having been more or less transferred to the female But what are we to conclude with respect to certain birds in which for instance the eyes differ slightly in colour in the two sexes[44] In some cases the eyes differ conspicuously thus with the storks of the genus Xenorhynchus those of the male are blackish hazel whilst those of the females are gamboge-yellow with many hornbills (Buceros) as I hear from Mr Blyth[45] the males have intense crimson eyes and those of the females are white In the *Buceros bicornis* the hind margin of the casque and a stripe on the crest of the beak are black in the male but not so in the female Are we to suppose that these black marks and the crimson colour of the eyes have been preserved or augmented through sexual selection in the males? This is very doubtful for Mr Bartlett shewed me in the Zoological Gardens that the inside of the mouth of this Buceros is black in the male and flesh-coloured in the female and their external appearance or beauty would not be thus affected I observed in Chil... that the ... in the con... [illegible]

... also a small ... [illegible]

... to think of the bull-... comb of the condor which does not appear to us in the least ornamental? The same question may be asked in regard to various other characters, such as the knob on the base of the beak of the ...

[40] Graba, *Tagebuch Reise nach Färö*, 1830, ss. 51–54. Macgillivray, *Hist. of British Birds*, vol. ... p. 745. *Ibis*, vol. v, 1863, p. 469.

[41] Graba, ibid. s. 54. Macgillivray, ibid. vol. ...

[42] *Variation of Animals and Plants under Domestication*, vol. ... p. 9...

[43] On these points see also *Variation of Animals and Plants under Domestication*, vol. i. p. 253; vol. ii. pp. ...

[44] ... *Ibis*, 1860 p. 206 ... 1863 p. ...

[45] ... *Birds of India*, vol. i. pp. 243–245.

[46] *Zoology of the Voyage of H. M. S. Beagle*, 1841, p. 6.

any existing bird has acquired his m gnificent colo rs r th r rnam nts, w ought to be-
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part ally trace f th r form r charac s.
Instead f entering n ted u d tails re pect ing arious gro ps in whi h triki g nstances of gradati oo ld be gi n t seem the best

ir descent, int nsely blue ind nted centre surro nded by ri h green zone this by a broad coppe y brown zone, and th s by five th r n rrow zone f l ghtly diff rent indes-cent hades A trifl ng characte in tl d sc deser es n t ce the barbs, f a pace along n f th co ce tri zon s are m re r less d titute of th ir barb les, so that a part f th disc i urrounded by an alm st t an parent zone which gi es it a highly finished aspect. But I have elsewhere described[49] an exactly

F G. 54 F th f P acock, bo t two-thirds of natural siz drawn by Mr F rd.
Th transpare t is rep es ted by th term st hit zo e, confined t the pper d of th disc.

plan to tak n tw trongly ma ked cases f nstance th t f th peacock, d t see if l ght can be tl rown n th tep by whi h tl l rd l a l ecom so pl nd dly decorated

tand separ t are decomposed b t thi is tl case th th f th rs f many pec s, and th som an ti f th d m ti f wl and p geo Th barb co lesce to ard th tr m ty f th h ft f rming th al d sc ocellus, which certainly f th most bea tiful objects n th wo ld It consists f an

analog u ri ti n n th hackl of a s b-v ri ty f th g m -cock in wl h th t ps, h g m tall lustre are separ ted from th l w p rt f th f ther by a ymm tri cally sh ped tran.parent zo e composed f th ked porti ns f th barbs. Tl low

traces, as m y be seen in th d wing (fig 4) f ind ntat ns, r ther breaks. These nd n tat ns are comm n to th Indian and J an peacocks (*P ristatus* and *P m t cus*) and

[49] *riation of Animals nd Pl nts under Domestication,* l. i., p. 254

sists of a black centre including a semi trans-parent crescent shaped mark surrounded by ... ochre yellow black ochre yellow

ments have been developed the process has probably been a simple one at least with in sects for as Mr Trimen writes to me no characters of mere marking or colouration are so unstable in the Lepidoptera as the ocelli both in number and size Mr Wallace who

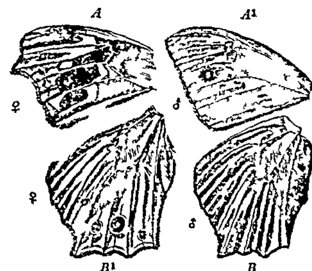


Fig 53 *Cyllo leda,* Linn from a drawing by Mr Trimen shewing the extreme range of variation in the ocelli.

... from M urit u upper surface of fore-

first called my attention to this subject shewed me a series of specimens of our common meadow brown butterfly (*Hipparchia janira*) exhibiting numerous gradations from a simple minute black spot to an elegantly shaded ocellus In a S African butterfly (*Cyllo leda* Linn) belonging to the same family the ocelli are even still more variable In some specimens (*A* fig 53) large spaces on the upper surface of the wings are coloured black and include irregular white marks and from this state a complete gradation can be traced into a tolerably perfect ocellus(*A*[1]) and this results from the contraction of the irregular blotches of colour In another series of specimens a gradation can be followed from excessively minute white dots, surrounded by a scarcely visible black line(*B*) into perfectly symmetrical and large ocelli (*B*[1]) [48] In cases like these the development of a perfect ocellus does not require a long course of variation and selection

With birds and many other animals, it seems to follow from the comparison of allied species that circular spots are often generated by the breaking up and contraction of stripes. In the tragopan pheasant faint white lines in the female represent the beautiful white spots in the male and something of the same kind may be observed in the two sexes of the Argus pheasant However this may be appearances

... tral point ...

latter is thus rendered lighter and on the other hand that a white spot is often formed by the colour being driven away from a central point so that it accumulates in a surrounding darker zone In either case an ocellus is the result The colouring matter seems to be a nearly constant quantity but is redistributed either centripetally or centrifugally The feathers of the common guinea fowl offer a good instance of white spots surrounded by darker zones and wherever the white spots are large and stand near each other the surrounding dark zones become confluent In the same wing feather of the Argus pheasant dark spots may be seen surrounded by a pale zone and white spots by a dark zone Thus the formation of an ocellus in its most elementary state appears to be a simple affair By what further steps the more complex ocelli which are surrounded by many successive zones of colour have been generated I will not pretend to say But the zoned feathers of the mongrels from differently coloured fowls, and the extraordinary variability of the ocelli on ... lead us to conclude that

Gradation of Secondary Sexual Characters

Cases of gradation are important as shewing us that ... acquired ... discover the actual ...

[48] This woodcut has been engraved from beautiful drawing most kindly made for me by Mr Trimen see also his description of the ... of ... the colour and shape of the ... of this butterfly in his *Rhopalocera Africæ* ... p. 186

Jerdon, *Birds of India*, vol. iii., p. 517

each tail-covert, though till plainly betraying its double rigin. Th se confluent ocelli diff r from th singl ocelli f th peacock in h ving an indentatio t both ds, inst ad of only at the lower or basal nd Th explanati n, ho er of this diff rence is n t difficult in some species of P lyplectron the tw al ocelli on the sam f th r tand parallel to ach other in th pecies (as in *P ch quis*) th y con r t ward nd n w th partial confluence of tw con g nt ocelli w uld manifestl lea a much deeper ind ntati n t the di r t than t the con ergent nd It also manifest that if the con erg nce w re strongl pronounced and th conflu nce com plete, th indentati n t th co rgent nd would tend t disappear

Th l feat both peci f th pea

respect th dm remains
f P l plectro which in most of th

t

be so. Th central tail f th rs f *P napole is* ha th tw ocelli n ach sid f th shaft perfectly d loped but th inn ocellus becomes less and less consp cu us n th m re exterior tail-feath rs, until m re shad w rudim t is l ft th nn sid f th ute most f th Again, in *P malaccens* th ocelli th tail-co rts are as we h seen, confluent and these f th rs are f unus al length, being two-thirds f th l gth f th tail-f th rs, so that in both these respects they pproach tl tail-co rts f th peacock. N w in *P malaccense* th tw ce tral tail f athers alo are rnam ted ach with tw brightl -coloured ocelli, th inn ocellus h v ing completely disappeared from all th ther tail-feath rs. Consequ ntly th tail-co rts and tail-feathers f this pecies of P lyplectron mak ar pproach tructure and rna mentat on t th corresponding f th rs of th peacock.

As far th n, as gradation throw light th steps b whi h th magnificent train f th peacock has been acquired hardl anything more is needed If w pi ture t ursel es a progenito of th peacock in an almost exactly intermediat condition betwee the xisting peacock, with his enorm usly el ngated tail co rts, rnamented with single ocelli and an ordinary gallinaceous b rd with short tail co erts, merely potted with some colour we shall see bird allied to P l plectron—that is, with tail-co rt c pable of erect on and ex pansi n rnamented with two partially co fl ent ocell and lo g en gh almost to con ceal th tail f thers, the l tt r ha ing already partiall lost th r ocelli Th indentation of th ce tral d sc and f the surrounding zone of th ocellus, in both pec es of pe cock peak plainly n fa ur of this w and i th rw se in xplicable Th males of Polyplectron are no do bt beautiful birds, b t their beauty wh n wed from a l ttl di tance cann t be compared with that f th peacock. Many f mal pro nitors of the peacock mu t during a lo g line of descent, l a pprec ted this superi rity f th y ha consciousl by th continued pref rence f r th m t be tiful males, rend red the peacock the most pl ndid f living b rds.

A gus ph as t.—In th r xcell nt case f in t t n is ff red by the ocell n the wing f ath rs of th Argus ph asant, wh ch are shaded n so w nd rful manne as to resem ble b loose w thin sockets, and con sequ I pr has nced arti ts, t chance—to the f rtu t s conco rse f at ms of col uring matt r That th se rnam nts h uld h been f rmed thro gh th selecti n f many s ccessi ar ti ns, n t f which was origi all in tended to prod ce the ball and sock t ffect, seems as incred bl as that of Raph l Mad nnas sh uld ha been f med b th selecti n f chance d ub f paint made b a l g successi n of young artists, not f wh m t nded t first t d w th h man figure In rd to disco h w the ocelli h bee d l ped we cann t look to a long li f prog nitors, n to many closely allied f rms, f uch d n t n w xist. But f rtu nat ly th se eral f ath rs n th wing uffice t gi u a cl t th problem and th y pro to d m nstration th t a grad ti n t l ast possibl from m re pot to a finish d ball-and sock t ocell s.

The wing f ath rs, be ri the ocelli are co red w th dark tripes (fig 57) with row of dark pots (fig 59) ach stripe row of pots running obliquely d wn th t sid f th shaft to f th ocelli Th pots are

they seem to deserve particular attention as probably connected with the development of the ocellus but for a long time I could not conjecture their meaning

If we admit the principle of gradual evolution there must formerly have existed many species which presented every successive step between the wonderfully elongated tail coverts of the peacock and the short tail coverts of all ordinary birds and again between the magnificent ocelli of the former and the simpler ocelli or mere coloured spots on other birds and so with all the other characters of the peacock Let us look to the allied Gallinaceæ for any still existing gradations The species and sub species of Polyplectron inhabit countries adjacent to the native land of the peacock and they so far resemble this bird that they are sometimes called peacock pheasants I am also informed by Mr Bartlett that they resemble the peacock in their voice and in some of their habits During the spring the males as previously described strut about before the comparatively plain coloured females expanding and erecting their tail and wing feathers, which are ornamented with numerous ocelli I request the reader to turn back to the drawing (fig 51 p 472) of a Polyplectron In *P napoleonis* the ocelli are confined to the tail and the back is of a rich metallic blue in which respects this species approaches the Java peacock *P hardwickii* possesses a peculiar top-knot which is also somewhat like that of the Java peacock In all species the ocelli on the wings and tail are either circular or oval and consist of a beautiful iridescent greenish blue or greenish purple disc with a black border This border in *P chinquis* shades into brown edged with cream colour so that the ocellus is here surrounded with variously shaded though not bright concentric zones The unusual length of the tail-coverts is another remarkable character in Polyplectron for in some of the species they are half and in others two-thirds as long as the true tail feathers The tail-coverts are ocellated as in the peacock. Thus the several species of Polyplectron manifestly make a graduated approach to the peacock in the length of their tail-coverts in the zoning of the ocelli and in some other characters.

Notwithstanding this approach the first species of Polyplectron which I examined almost made me give up the search for I found not only that the true tail feathers which in the peacock are quite plain were ornamented with ocelli but that the ocelli on all the feathers differed fundamentally from those of the peacock in there being two on the same feather (fig 55) one on each side of the shaft.



FIG 55 Part of a tail covert of *Polyplectron chinquis* with the two ocelli of natural size.

Hence I concluded that the early progenitors of the peacock could not have resembled a Polyplectron But on continuing my search I observed that in some of the species the two ocelli stood very near each other that in the tail feathers of *P hardwickii* they touched each other and finally that on the tail-coverts of this same species as well as of *P malaccense* (fig 56) they were actually confluent As the central part alone is confluent an indentation is left at both the upper and lower ends and the surrounding coloured zones are likewise indented A single ocellus is thus formed on



FIG 56 Part of tail covert of *Polyplectron malaccense* with the two ocelli partially confluent. of natural size.



FIG. 58 Basal part of the secondary wing-feather nearest to the body

described basal spots, together with the next higher one in the same row, to a curious ornament, which cannot be called an ocellus, and which I shall name from the want of a better term, an elliptic ornament. These are shown in the accompanying figure (fig. 59). We here see several oblique rows, A, B, C, D, &c. (see the lettered diagram on the right hand) of dark spots of the usual character. Each row of spots runs down to and is connected with one of the elliptic ornaments, in exactly the same manner as each stripe in fig. runs down to, and is connected with, one of the ball-and-socket ocelli. Looking at any one row, for instance, B, in fig. 59, the lowest mark (b) is thicker and considerably longer than the upper spots, and has its left extremity pointed and curved upwards. This black mark is abruptly bordered on its upper side by a rather broad space of richly shaded tints, beginning with a narrow brown zone, which passes into orange, and this into a pale leaden tint, with the end towards the shaft much paler. These shaded tints together fill up the whole inner space of the elliptic ornament. The mark (b) corresponds in every respect with the basal shaded spot of the simple feather described in the last paragraph (fig. 58), but is more highly developed and more brightly

coloured. Above and to the right of this spot (b, fig. 59), with its bright shading, there is a long narrow black mark (c), belonging to the same row, and which is arched a little downwards so as to face (b). This mark is sometimes broken into two portions. It is also narrowly edged on the lower side with a fulvous tint. To the left of and above (c), in the same oblique direction, but always more or less distinct from it, there is another black mark (d). This mark is generally sub-triangular and irregular in shape, but in the one lettered in the diagram it is unusually narrow, elongated, and regular. It apparently consists of a lateral and broken prolongation of the mark (c), together with its confluence with a broken and prolonged part of the next spot above; but I do not feel sure of this. These three marks, b, c, and d, with the intervening bright shades, form together the so-called elliptic ornament. These ornaments placed parallel to the shaft, manifestly correspond in position with the ball-and-socket ocelli. Their extremely elegant appearance cannot be appreciated in the drawing, as the orange and leaden tints, contrasting so well with the black marks, cannot be shown.

Between one of the elliptic ornaments and a

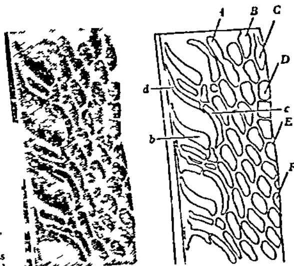


FIG. 59 Portion of one of the secondary wing-feathers near to the body, shewing the so-called elliptic ornaments. The right-hand figure is given merely as a diagram for the sake of the letters of reference.

A, B, C, D, &c. Rows of spots running down to and forming the elliptic ornaments. b. Lowest spot or mark in row B. c. The next succeeding spot or mark in the same row. d. Apparently a broken prolongation of the spot c. in the same row B.

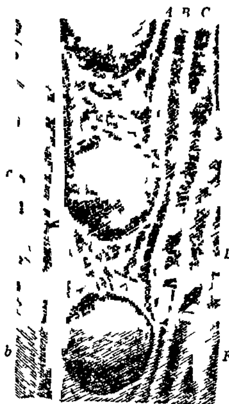


FIG 57 Part of secondary wing feather of Argus pheasant showing two perfect ocelli

to the left of the shaft has been cut off]

generally elongated in a line transverse to the row in which they stand They often become confluent either in the line of the row—and then they form a longitudinal stripe—or transversely that is with the spots in the adjoining rows and then they form transverse stripes A spot sometimes breaks up into smaller spots which still stand in their proper places

It will be convenient first to describe a perfect ball and socket ocellus This consists of an intensely black circular ring surrounding a space shaded so as exactly to resemble a ball The figure here given has been admirably drawn by Mr Ford and well engraved but a woodcut cannot exhibit the exquisite shading of the original The ring is almost always slightly broken or interrupted (see fig 57) at a point in the upper half a little to the right of and above the white shade on the enclosed ball it is also sometimes broken towards the base on the right hand These little breaks have an important meaning The ring is always much thickened with the edges ill defined towards the left hand upper corner the feather being held erect in the position in which it is here drawn Beneath this thickened part there is on the surface of the ball an oblique almost pure white mark, which shades off downwards into a pale leaden hue and this into yellowish and brown tints, which insensibly become darker and darker towards the lower part of the ball It is this shading which gives so admirably the effect of light shining on a convex surface If one of the balls be examined it will be seen that the lower part is of a brown tint and is indistinctly separated by a curved oblique line from the upper part which is yellower and more leaden this curved oblique line runs at right angles to the

woodcut does not in the least interfere with the perfect shading of the ball It should be particularly observed that each ocellus stands in obvious connection either with a dark stripe or with a longitudinal row of dark spots for both occur indifferently on the same feather Thus in fig 57 stripe A runs to ocellus a B runs to ocellus b stripe C is broken in the upper part and runs down to the next succeeding ocellus not represented in the woodcut D to the next lower one and so with the stripes E and F Lastly the several ocelli are separated from each other by a pale surface bearing irregular black marks

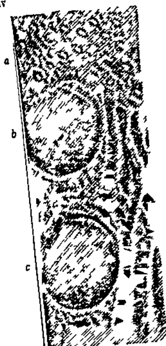
I will next describe the other extreme of the series namely the first trace of an ocellus. The short secondary wing feather (fig 58) nearest to the body is marked like the other feathers, with oblique longitudinal rather irregular rows of very dark spots The basal spot or that nearest the shaft in the five lower rows (excluding the lowest one) is a little larger than the other spots of the same row and a little more elongated in a transverse direction It differs also from the other spots by being bordered on its upper side with some dull fulvous shading But this spot is not in any way more remarkable than those on the plum

ing wing feathers an absolutely insensible gradation can be traced from one of the last

r a ph tograph,

wh h
g en n
as n th
the f ath s wl cl a h ld p rpe u
th l te ma ks n the ocelli repre ent ng
l ght reflected from a con x urface are at tl
upper f tl er nd tl at s, r di ectc l
upward and th b rd wh lst d splay ng him
self n the g ound w uld n tu ally be llumi
nated from bo e But he e com tl rious
po t tl ter f ath s are held alm t h n
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as s th fact, they are thus plac d! Hence th
ocell n the se r l fe th rs th ugh occupy
ing ery d ff re t po ti s witl re pect to the
l ght, ll ppear as f llumi ted f om ab e
ju t as an t t w uld h l aded tl m
N erth l ss tl ey ar n t ll m ted from
tri tly th same po nt as they o ght to b f
th what m rks n th ocelli of the f ath rs
wh ch h ld alm t l n ontally placed
th too m ch t w ds the furth nd tl t
th y ar n t uffi ntly late l We ha e
h w nor ght to xpe t bsol t p rfecti n
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select any m than w ha n a part
nod fied th gh natu al select n f l use
f r n tance that w ndro o g n th hu
t d w k w what H lmh ltz the

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F 61 P rti ea mm t f f th secondary g f th rs, beari g p fect ball d k t oc lli.

a. O nam ted ppe p rt b t pp rmost, mp rfect b ll d sock t oc llus. (Th had g bo th h t m k th sum m t f th ocellus h l ttl too d k)

c. P rfect ocellus

brok prol g t f m th t l gl pot
From tl abse f tl ppe and th k ed
part f tl n th ppe m t ocell s, tl gh
l l respects, ppe as f ts
l

l pe f t than th th f tl s, and

are tl co t ar fte brok p into
mall p ts, so th t tw three row run
d w t th sam oc ll
Tl till remain an th ry curi us
po t, fir t bserved by Mr T W Wood

m t l

l f ll ed f m mpl pots to th w
f l b ll and ocket rn m nts M G ld
wh ki dly g e m som f th e f tl
f lly agree w th m in th mpl t ness f tl
g ad t on It b s th t th tag in
d l pm nt exl b ted by tl e feath rs n the
sam b rd d n t t ll nece sarily sh w us th
t p passed tl ro gh by th xtin t p g m
to f th pec b t th prob bly g e u
th l t th act l t p and th y at l ast
p to d m nst t n th t a g ad t is
po bl B ar ng m nd h w ar fully the
mal A g pl asant displ y his plum b
f tl f mal as w ll as the many f ts
d g t p b bl th t f mal b d p f

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t ns. 1873 pp 219 227 269 390

perfect ball and socket ocellus the gradation is so perfect that it is scarcely possible to decide when the latter term ought to be used The passage from the one into the other is effected by the elongation and greater curvature in opposite directions of the lower black mark (*b* fig 59) and more especially of the upper one (*c*) together with the contraction of the elongated sub triangular or narrow mark (*d*) so that at last these three marks become confluent forming an irregular elliptic ring This ring is gradually rendered more and more circular and regular increasing at the same time in diameter I have here given a drawing (fig 60) of the natural size of an ocellus not as



FIG 60 An oc llu in an nt rmed ate cond ti n betwe n th ll ptic o am t and the p rfect ball and ocket c llus

yet quite perfect The lower part of the black ring is much more curved than is the lower mark in the elliptic ornament (*b* fig 59) The upper part of the ring consists of two or three separate portions and there is only a trace of the thickening of the portion which forms the black mark above the white shade This white sh l + 11

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... or four elongated black marks by which the ring has been formed may often be detected The irregular sub triangular or narrow mark (*d* fig 59) manifestly forms by its contraction and equalisation the thickened portion of the ring above the white shade on a perfect ball and socket ocellus The lower part of the ring is invariably a little thicker than the other parts (see fig 57) and this follows from the lower black mark of the elliptic ornament (*b* fig 59) having originally been thicker than the upper mark (*c*) Every step can be followed in the process of confluence and modification and the black ring which surrounds the ball of the ocellus is unquestionably formed by the union and modification of the three black marks *b c d* of the elliptic ornament. The irregular zigzag black marks between the successive ocelli (see again fig 57) are plainly due to the breaking up of the somewhat more regular but similar marks between the elliptic ornaments

The successive steps in the shading of the ball and socket ocelli can be followed out with equal clearness The brown orange and pale leadened narrow zones which border the lower black mark of the elliptic ornament can be seen gradually to become more and more softened and shaded into each other with the upper lighter part towards the left hand corner rendered still lighter so as to become almost white and at the same time more contracted But even in the most perfect ball and socket ocelli a slight difference in the tints though not in the shading between the upper and lower parts of the ball can be perceived as before noticed and the line of separation is oblique in the same direction as the bright coloured shades of the elliptic ornaments Thus almost every minute detail in the shape and colouring of the ball and socket ocelli can be shewn to follow from gradual changes in the elliptic ornaments and the development of the latter can be traced by equally small steps from the union of two almost simple spots the lower one (fig 58) having some dull fulvous shading on its upper side

The extremities of th ... secondary ... and sock t ... g 61) The ... cease upwards and become confused and above this limit the whole upper end of the feather (*a*) is covered with white dots surrounded by little black rings standing on a dark ground The oblique stripe belonging to the uppermost ocellus (*b*) is barely represented by a very short irregular black mark with the usual curved transverse base As this stripe is thus abruptly cut off we can perhaps understand from what has gone before how it is that the upper thickened part of the ring is here absent for as before stated this thickened part apparently stands in some relation with a

performers b t hether the most bea tiful t e most pugnaci u was the accepted su tor I know not. M G uld, aft r describing the peculiar pluma of the L rostict adds, th t ornament and ari t is th sol object I ha n sed b t l ttle d ubt * If this be admitted w can perce v that the males wh ch I ring f rmer times w re decked in th most el gant and no l mann would ha e gained an ad antage n t in the ordinary struggl f r lif but in ri alry with oth er males, and would have l ft a larg r numbe f off prin to inh rit th ir newly acquired bea ty

* Introduction to the Trochilidæ 1861 p. 110.

the more attractive males no one who a lmits the agency of sexual selection in any case will deny that a simple dark spot with some fulvous sha ling might be converted through the approximation and modification of two adjoin ing pots together with some slight increase of colour into one of the so called elliptic orna ments These latter ornaments have been shewn to m iny persons and all have admitted that they are beautiful some thinking them even more so than the ball an l socket ocelli As the econdary plumes became lengthened through sexu il selection and as the elliptic ornaments increa ed in diameter their colours apparently bec ime less bright and then the ornamentation of the plumes had to be gained by an improvement in the pattern and shading and this process was carried on until the won derful ball and socket ocelli were finally level oped Thu we can un lerstand—and in no other way as it seems to me—the pre ent condition an l origin of the ornaments on the wing feather of the Argus pheasant

From the light afforded by the principle of gradation—from what l

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er
ai y) of the immature plumage of young bird —we can sometimes in licate with a certain amount of confidence the probable steps by which the males have acquire l their brilliant plumage and various ornaments yet in many cases we are involved in complete darkness Mr Gould several years ago pointed out to me a humming bird the *Uro h te benja mini* remarkable for the curious differences between the sexes The male besides a splen did gorget has greenish black tail feather with the four *central* ones tipped with white in the female as with mo t of the allied pecies the three *outer* tail feathers on each ide are tipped with white so that the male has the four central whilst the female has the six exterior feathers ornamented with white tips What makes the c se r t

r Goul l loe not kro v a sin gle species besid s the Urostiete in which the male has the four central f athers tipped with white

The Duke of Argyll in comm nting on this case [14] passes over sexual selection and asks

What explanation does the law of natural selection give of such es as
an l I

s one specie alone so as to have acquired white tips The variations may have been gradual or somewhat al rupt as in the case recently given of the humming birds near Bogota in which certain indivi luals al ne have the central tail feathers tipped with beautiful green In the femal of the Uro tiete I noticed extremely minute or ru limental white tips to the two outer f the four central black tail feathers so th

a ii
c tips together with the mall white ear tuft certainly a l l as the Duke of Argyll admits to the beauty of the male an l whit ness is apparently appreciated by other birds as may be inferred from such ca s as the snow white male of the bell bird The state ment ma le by Sir R Heron shoul l not be forgotten namely that his peal n when debarre l from acces to the pied peacock woul l not unite with l

s
c Uro tiete h ul l have been pecially selecte l for the sake f rnament for the next succeeding genus in the family tak s it name of Metallura from th plendour f these feathers We have m reover good vi l nce that humming bir l take s pecial pain in dis playing their ta l f athers Mr Belt [15] after describing the beauty of the *Fl uga i ll vora* s ys I hav een the femal itting on a branch an l two mal s di playing their char m front of her One w ul l hoot up like a rocket then u l l nly expan ling the n white tail like an inve te l pa achut l s h descen l in front of her turning roun l g lu ally to l ev olf back and front If ex pan le l what tail covere l mor pa th n all the re t f the bir l and was evi l ntly the gra l f ture in the pe f rmance Whil t on male was descen ling th other oul l hoot up an l come lo ly down expan led The enter tainm nt would en l in a fight l etween the two

[14] *The Reig f Law* 1867 p 247

[15] *The Nat alist n Nica gua*, 1874 p. 112.

there can be no doubt that th male h brid offspring would have a much lo er tail than that of the pure offsprin of th common pheasant. On the th r hand, if th femal common pheasant, with a tail much longe than that of the f mal Sœmmerring ph asant were crossed with the mal of th latt the male hybrid ff pring would ha e a much shorter tail than that of th pure off pring of Sœmmerring pheasant.

Our fancier in ord t mak his n w breed with the males of a pale-bl e tint, and th f males unchan ed w uld ha to co t selecting th males during many gen rations and each stage of paleness would ha to be fixed in the males, and rendered lat nt n th females. The task w uld be an xtremel diffi cult one and has ne r been tried, b t m ght possibl be successf ll carried t. Th hi f obstacle would be th l and complet loss of the pale-bl tint from th necessit of re eated crosses w th tl lat f male the latter not having t first any latent t nd ncy to produce pale-bl off prin

transmission t th male sex, th task of mak ing new breed of th desired kind would be as for such males w ld simpl ha e t be selected and matched w th ordinary f males. An analogous case has actuall occurred, f there are breeds of th pigeon in Belgi m in which the male lon are marked w th bla k striæ. So again M T g tm ie has recentl shewn that dragons not rarely prod ce l coloured birds, which are almost alw l ns and he himself has bred t n such f mal s. It is on the other hand a rs unusual t he a sil er male is prod ced so that nothi ould be asier if desired, than t mak breed of dragons with bl males and il f males. This t ndency is indeed so trong that h n Mr Te tmei t last g t a sil male and matched him with one of th silve females, h expected t get breed w th both se es thus coloured h was how disappoi ted, f th young male re erted t th blue colour of his

grandfath the you g female alone be g silv No doubt with pati nce this t nden to re ersion in the males, reared from an occa sional silver male matched with a sil r h n might be elimin ted and then both sexes w uld be colo red al ke and this ery process has been followed w th ccess by Mr Esquil ant the case of sil e turb ts.

With fowls, ariati ns of colou limited in th ir transmission to th male sex, habitually occur Wh n this f rm of inh ritance pre ails, t might well happen that som of th ucces- e ari ti n would be transf rred t th femal who w uld th n slightl resembl the mal as actually occ rs in som breeds. Or again, the gre t n mber but not all, of the ccessi e t ps mig t be transferred to both sexes, and the f mal would th n closel re- semble th mal Th re can hardly be doubt that th i tl ca se of th mal po te p con ha g a som what larg crop, nd f th

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tl and h had no wis that th se har act rs sho ld be m re tro gl displa ed n th mal than in th f mal et this th case with both breeds.

Th sam process w ld ha e to be f llowed and th sam difficult es ncount red, f t w re desired to mak a breed w th th f males alo of som n w colo

Lastl o fanci m ht wish t mak a breed w th th two se es diff ring from ach oth and both from th parent species. H re th d fficult would be trem unless the successi ariations w re from th first sex all lim ted n both sides, and then th re w ld be n d fficult W see tl with th f wl thus tl t e es of th pencilled Hamb rgh d ffer re tl from ach oth and from th two se es of th aboriginal *Gallus bank* and both are n w k pt constant to their standard of celle ce b continued selection, whi h w uld be impossible unless th distin ti e charact rs of both were limited in th ir trans- m sion

Th panid f wl off rs a more curio case th m le has an imm nse comb but som f th ccess ariati ns, b th accumulation of hich t was acquired ppear t ha e been transf rred t th f male for she has comb man t mes larg than that of th f males f th parent pecies. B t th comb of th f mal diff rs in respect from that f th mal f t is pt t lop r and w thin a recent period

[1] Temminck says that the tail of the female *Pha- sia Sœmmerr* l six inches long, *Pl nche coloriée* ol 1838, pp. 4 and 88, the measure- ments above gi en were made for me b Mr Sclater For the common pheasant, see Macgillivra *His- tory of British Birds* ol i, pp. 118-121

[2] Dr Chapuis, *Le P geon V yageur Belge* 1865, p. 8

[3] *The Field*, Sept. 15 1

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CHAPTER XV

BIRDS—*Continued*

We have in this chapter to consider why the females of many birds have not acquired the same ornaments as the male and why on the other hand both sexes of many other birds are equally or almost equally ornamented? In the following chapter we shall consider the few cases in which the female is more conspicuously coloured than the male

In my *Origin of Species*[1] I briefly suggested that the long tail of the peacock would be inconvenient and the conspicuous black colour of the male capercailzie dangerous to the female during the period of incubation and consequently that the transmission of these characters from the mal ...

... instances but after mature reflection on all the facts ...

... from the first limited in their transmission to the same sex in which they first arose Since my remarks appeared the subject of sexual colouration has been discussed in some very interesting papers by Mr Wallace who believes that in almost all cases the successive variations tended at first to be transmitted equally to both sexes but that the female was saved through natural selection from acquiring the conspicuous colours of the male owing to the danger which she would thus have incurred during incubation

This view necessitates a tedious discussion on a difficult point namely whether the transmission of a character which is at first inherited by both sexes can be subsequently limited in its transmission to one sex alone by means of natural selection We must bear in mind as shewn in the preliminary chapter on sexual selection that characters which are limited in their development to one sex are always latent in the other An imaginary illustration will best aid us in seeing the difficulty of the case we may suppose that a fancier wished to make a breed of pigeons in which the males alone should be coloured of a pale blue whilst the females retained their former slaty tint As with pigeons characters of all kinds are usually transmitted to both sexes equally the fancier would have to try to convert this latter form of inheritance into sexually limited transmission All that he could do would be to persevere in selecting every male pigeon which was in the least degree of a paler blue and the natural result of this process if steadily carried on for a long time and if the pale variations were strongly inherited or often recurred would be to make his whole stock of ...

... loss of the pale blue tint for the primordial slaty colour would be transmitted with prepotent force Supposing however that some pale blue males and slaty females were produced during each successive generation and were always crossed together then the slaty females would have if I may use the expression much blue blood in their veins for their father grandfathers &c will all have been blue birds Under these circumstances it is conceivable (though I know of no distinct facts rendering it probable) ...

... their male offspring their female offspring still inheriting the slaty tint If so the desired end of making a breed with the two sexes permanently different in colour might be gained

The extreme importance or rather necessity in the above case of the desired character namely pale blue ... being present though in a latent state in the female so that the male offspring should not be deteriorated will be best appreciated as follows the male of Sœmmerring's pheasant has a tail thirty seven inches in length whilst that of the female is only eight inches the tail of the male common pheasant is about twenty inches in length and that of the female twelve inches long Now if the female Sœmmerring pheasant with her short tail were crossed with the male common pheasant

1 ... edition 1866 p 241
2 *Westminster Review* July 1867 ... *Journal of Travel* vol i, 1868, p ...

ance ha been modified b sexual selection, the females having been left unchanged, or only partial and indirectly thus changed o ether the f males ha been pecially modi fied through natural selection fo th sak of protection. I will therefore discuss this q s- tion at som length, en more full than ts intrinsic importance deserves f various curi ous collateral points ma thus be con eniently considered.

Before w ente on the ubject of colour more especial in ref rence to Mr Wallace conclusions, t ma be useful to discuss some other sexual differences under a similar point of view A breed of f wls form rly xisted in Germany[4] in which the hens w re furnished

probable that with the f males f th wild Gallinaceae the lev lopment of sp rs had been checked through natural selection, from th injury thus caused to their nests. This seemed all the more probable as nim sp rs, which ould not be injurious d ring incubation, are often as well d loped in the f male as in the male though in not a f w cases they are rathe larger in the male. Whe th male is furnished with leg-spurs th f male almost al ex hibits rudiments of th m,—the rudiment

sequently bee lost thro gh disuse or natural selection. B t if this view be admitted, t would ha e to be xtended to inn m rabl th cases and t impuses that the femal pro em tors of the xisting pur-bearing species were once encumbered th an injurious ppendage.

In some few genera and species, as in Gallo- perdix, Acomus, and th J an peacock (P m ticus) the females, as ll as the males,

purs so that the spurs ha not bee remo ed Or are to suppose that th f males of these severa pecies especiall require purs for their defence It is more probable conclusion that both the presence and al sence of purs in the females result from different la f inheri

tance ha ing prevailed ind pendently of natural selecti n W th th many f males in which spurs ppear as rudim nts, we may concl d that som f w of th ucces e vari tions, through which th y were d eloped in th males, occurred ry earl in life, and w re consequently tran ferred to th f males. In the oth and much rare cases, in which th fe- males possess full de loped purs, w may conclud that all the successi e ariations were transf rred to them and that they gradu ally acquired and inherited th hab t of not disturbing their nests.

Th ocal organs and the f athers variousl modified f producing sound as w ll as the prope instincts f u ing them ften diff r n the two sexes, b t are som times the sam in both. Can ch diff rences be accounted fo by th males ha in acquired these organs and instincts, whilst the f males ha been sa ed from inh riting them, n account of the danger t which the woul l ha been xposed l y ttracting the attention f bird o beasts of pre This does not seem to m probable, wh w th nk of th m lt tude of birds which with impunit gladd n th country w th th ices durin th spring It a saf conclusion that, as ocal and instrumental o gans are f pecial service onl to the males durin their court ship, these organ w re de eloped thro gh sexual selection and their con tant use in that se alo —th successi variations and th ffects of use ha in been from the first more o less limited in transmission to the male off pring.

Many analog us cases co ld be adduced those f instance of the plumes on th h ad being eneral longe in th mal than in the f male som times of equal l ngth in both se es, and occas onally absent in the f male — these se al cases occurring n th same group of birds. It would be difficult t account for uch diff rence between the sexes by the f mal having been benefited b possessin a slightl short crest than th m and ts consequ nt diminution or complet uppres- sion thro gh natural selection. B t I will take more f vourab case nam ly the length of the tail. The lo train of the peacock w uld ha been not onl incon nient but dang ous t th peahen durin th period of incuba-

[4] Bechstein, Naturgeschichte Deutschlands 1793, B. iii. 339

Daines Barrington, however thought t probable (Philosophical Transactions 1773, p. 164) that few female birds sing because the talent w uld have bee da gerous t them durin ncubatio H adds, that similar iew m y possibl account for the inferiority of the female to the male in plumage

it has been ordered by the fancy that this should always be the case and success has quickly followed the order Now the lopping of the comb must be sexually limited in its transmission otherwise it would prevent the

the male must likewise be a sexually limited character otherwise it would prevent the comb of the female from lopping over

From the foregoing illustrations we see that even with almost unlimited time at command it would be an extremely difficult and complex perhaps an impossible process to change one form of transmission into the other through selection Therefore without distinct evidence in each case I am unwilling to admit that this has been effected in natural species On the other hand by means of successive variation which were from the first sexually limited in their transmission there would not be the least difficulty in rendering a male bird widely different in colour or in any other character from the female the latter being left unaltered or slightly altered or specially modified for the sake of protection

As bright colours are of service to the males in their rivalry with other males such colours would be selected whether or not they were transmitted exclusively to the same sex Consequently the females might be expected often to partake of the brightness of the males to a greater or less degree and this occurs with a host of species If all the successive variations were transmitted equally to both sexes the females would be indistinguishable from the males and this likewise occurs with many birds If however dull colours were of high importance for the safety of the female during incubation as with many ground birds the females which varied in brightness or which received through inheritance from the males any marked accession of brightness would sooner or later be destroyed But the tendency in the males to continue for an indefinite period transmitting to their female offspring their own brightness would have to be eliminated by a change in the form of inheritance and this as shewn by our previous illustration would be extremely difficult The more probable result of the long continued destruction of the more brightly-coloured females supposing the equal form of transmission to prevail would be the lessening or annihilation of the bright colours of the males owing to their continual crossing

... frequently were not eliminated yet they would not be favoured or selected for the male usually accepts any female and does not select the more attractive individuals consequently these variations would be liable to be lost and would have little influence on the character of the race and this will aid in accounting for the females being commonly duller coloured than the males

In the eighth chapter instances were given to which many might here be added of variations occurring at various ages and inherited at the corresponding age It was also shewn that variations which occur late in life are commonly transmitted to the same sex in

limited transmission can thus be accounted for It was further shewn that if a male bird varied by becoming brighter whilst young such variations would be of no service until the age for reproduction had arrived and there was competition between rival males But in the case of birds living on the ground and commonly in need of the protection of dull colours bright tints would be far more dangerous to the young and inexperienced than to the

natural selection on the other hand the males which varied in this manner when nearly mature notwithstanding that they were exposed to some additional danger might survive and from being favoured through sexual selection would procreate their kind As a relation often exists between the period of variation and the form of transmission if the bright coloured young males were destroyed and the mature ones were successful in their courtship the males alone would acquire brilliant colours and would transmit them exclusively to their male offspring But I by no means wish to maintain that the influence of age on the form of transmission is the sole cause of the great difference in brilliancy between the sexes of many birds

When the sexes of birds differ in colour it is interesting to determine whether the males

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birds in the United States, the male being vermilion, and the female light brownish-green. Now if brilliant colours had been extremely dangerous to birds whilst sitting on their open nests, the males in these cases would have suffered greatly. It might, however, be of such paramount importance to the males to be brilliantly coloured in order to beat their rivals, that this may have more than compensated some additional danger.

Mr Wallace admits that with the King-crows (Dicrurus), Orioles, and Pittidæ the females are conspicuously coloured, yet build open nests; but he urges that the birds of the first group are highly pugnacious and could defend themselves; that those of the second group take extreme care in concealing their open nests, but this does not invariably hold good; and that with the birds of the third group the females are brightly coloured chiefly on the under surface. Besides these cases, pigeons, which are sometimes brightly and

exposed nests. In another large family, that of the humming-birds, all the species build open nests, yet in some of the most gorgeous species the sexes are alike; and in the majority the females, though less brilliant than the males, are brightly coloured. Nor can it be maintained that all female humming-birds, which are brightly coloured, escape detection by their tints being green, for some display on their upper surfaces red, blue, and other colours.[13]

In regard to birds which build in holes or construct domed nests, other advantages, as Mr Wallace remarks, besides concealment are gained, such as shelter from the rain, greater warmth, and in hot countries protection from the sun; so that it is no valid objection to his view that many birds having both sexes obscurely coloured build concealed nests.[14] The female horn-bill (Buceros), for instance, of India and Africa is protected during incubation with extraordinary care, for she plasters

her ... is then kept a close prisoner during the whole period of incubation; yet the female hornbills are not more conspicuously coloured than many other birds of equal size which build open nests. It is a more serious objection to Mr Wallace's view, as is admitted by him, that in some few groups the males are brill

several of the Australian honey-suckers or Meliphagidæ.[17]

If we look to the birds of England we shall see that there is no close and general relation between the colours of the female and the nature of the nest which is constructed. About forty of our British birds (excluding those of large size which could defend themselves) build in holes, banks, rocks, or trees, or construct domed nests. If we take the colours of the female goldfinch, bullfinch, or blackbird as a standard of the degree of conspicuousness, which is not highly dangerous to the sitting female, then ... of the above forty birds the females of only twelve can be considered as conspicuous to a dangerous degree, the remaining

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[12] Journal of Travel, edited by A. Murray, vol. i., 1868, p. 281.

[13] Audubon, Ornithological Biography, vol. ... p. ...

conspicuous females could be given. See Mr Gould's magnificent work on this family.

Mr Salvin noticed in Guatemala (Ibis, 1864, p. 3...) that humming-birds were much more unwilling to leave their nests during very hot weather, when the sun was shining brightly, as if their eggs would be thus injured, than during cool, cloudy

the female Lamprornis porphyrurus is blackish-green on the upper surface, with the lores and sides of the throat crimson; the female Eulampis jugularis has the top of the head and back green, but the loins and the tail are crimson. Many other instances of highly

365, 383, 387, 389, 391, 414.

[14] Mr C. Horne, Proc. Zoolog. Soc., 1869, p. 243.

[17] On the nidification and colours of these latter species, see Gould's Handbook of the Birds of Australia, vol. i. pp. 504, 527.

tion and whilst accompanying her young Hence there is not the least *a priori* improbability in the development of her tail having been checked through natural selection But the females of various pheasants which apparently are exposed on their open nests to as much danger as the peahen have tails of considerable length The females as well as the males of the *Menura superba* have long tails and they build a domed nest which is a great anomaly in so large a bird Naturalists have wondered how the female Menura could manage her tail during incubation but it is now known[8] that she enters the nest head first and then turns round with her tail sometimes over her back but more often bent round by her side Thus in time the tail becomes quite askew and is a tolerable guide to the length of time the bird has been sitting Both sexes of an Australian kingfisher (*Tanysiptera sylvia*) have the middle tail feathers greatly lengthened and the female makes her nest in a hole and as I am informed by Mr R. B Sharpe these feathers become much crumpled during incubation

In these two latter cases the great length of the tail feathers must be in some degree inconvenient to the female and as in both species the tail feathers of the female are somewhat shorter than those of the male it might be argued that their full development had been prevented through natural selection But if the development of the tail of the peahen had been checked only when it became inconveniently or dangerously great she would have retained a much longer tail than she actually possesses for her tail is not nearly so long relatively to the size of her body as that of many female pheasants nor longer than that of the female turkey It must also be borne in mind that in accordance with this view as soon as the tail of the peahen became dangerously long and its development was consequently checked she would have continually reacted on her male progeny and thus have prevented the peacock from acquiring his present magnificent train We may therefore infer that the length of the tail in the peacock and its shortness in the peahen are the result of the requisite variations in the male having been from the first transmitted to the male offspring alone

We are led to a nearly similar conclusion with respect to the length of the tail in the various species of pheasants In the Eared pheasant (*Crossoptilon auritum*) the tail is of equal length in both sexes namely sixteen or seventeen inches in the common pheasant it is about twenty inches long in the male and twelve in the female in Sœmmerring's pheasant, thirty seven inches in the male and only eight in the female and lastly in Reeve's pheasant it is sometimes actually seventy two inches long in the male and sixteen in the female Thus in the several species the tail of the female differs much in length irrespectively of that of the male and this can be accounted

mission to the male sex than by the agency of natural selection resulting from the length of tail being more or less injurious to the females of these several allied species

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very conspicuous manner the nest is of such a nature as to conceal the sitting bird but when there is a marked contrast of colour between the sexes the male being gay and the female dull-coloured the nest is open and exposes the sitting bird to view This coincidence as far as it goes, certainly seems to favour the belief that the females which sit on open nests have been specially modified for the sake of protection but we shall presently see that there is another and more probable explanation namely that conspicuous females have acquired the instinct of building domed nests oftener than dull-coloured birds Mr Wallace admits that there are as might have been expected some exceptions to his two rules but it is a question whether the exceptions are not so numerous as seriously to invalidate them

There is in the first place much truth in the

8 Mr Ramsay in *Proc. Zoolog Soc* 1868, p. 50.

Journal of Travel, edited by A. Murray vol. i, 1868, p. 8.

Duke of Argyll remarks that a large domed nest is more conspicuous to an enemy, especially to all tree-haunting carnivorous animals, than a smaller open nest. Nor must we forget that with many birds which build open nests, the male sits on the eggs and aids the female in feeding the young: this is the case, for instance, with *Pyranga aestiva*,[11] one of the most splendid birds in the United States, the male being vermilion, and the female light brownish-green. Now if brilliant colours had been extremely dangerous to birds whilst sitting on their open nests, the males in these cases would have suffered greatly. It might, however, be of such paramount importance to the male to be brilliantly coloured, in order to beat his rivals, that this may have more than compensated some additional danger.

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'Journal of Travel,' edited by A. Murray, vol. i. 1868, p. 281.

Audubon, 'Ornithological Biography,' vol. i. p. 233.

Jerdon, 'Birds of India,' vol. ii. p. 108. Gould's 'Handbook of the Birds of Australia,' vol. i. p. 463.

For instance, the female *Eupetomena macroura* has the head and tail dark blue with reddish loins; the female *Lampornis porphyrurus* is blackish-green on the upper surface, with the lores and sides of the throat crimson; the female *Eulampis jugularis* has the top of the head and back green, but the loins and the tail are crimson. Many other instances of highly

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If we look to the birds of England we shall see that there is no close and general relation between the colours of the female and the nature of the nest which is constructed. About forty of our British birds (excluding those of large size which could defend themselves) build in holes in banks, rocks, or trees, or construct domed nests. If we take the colours of the female goldfinch, bullfinch, or black-bird, as a standard of the degree of conspicuousness, which is not highly dangerous to the sitting female, then out of the above forty birds the females of only twelve can be considered as conspicuous to a dangerous degree, the remain-

conspicuous females could be given. See Mr. Gould's magnificent work on this family.

[14] Mr. Salvin noticed in Guatemala ('Ibis,' 1864, p. 375) that humming-birds were much more unwilling to leave their nests during very hot weather, when the sun was shining brightly, as if their eggs would be thus injured, than during cool, cloudy, or rainy weather.

[15] I may specify, as instances of dull-coloured birds building concealed nests, the species belonging to eight Australian genera described in Gould's 'Handbook of the Birds of Australia,' vol. i. pp. 340, 362, 365, 383, 387, 389, 391, 414.

[16] Mr. C. Horne, 'Proc. Zoolog. Soc.' 1869, p. 243.

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tion and whilst accompanying her young Hence there is not the least *a priori* improbability in the development of her tail having been checked through natural selection But the females of various pheasants which apparently are exposed on their open nests to as much danger as the peahen have tails of considerable length The females as well as the males of the *Menura superba* have long tails, and they build a domed nest which is a great anomaly in so large a bird Naturalists have wondered how the female Menura could manage her tail during incubation but it is now known[8] that she enters the nest head first and then turns round with her tail sometimes over her back but more often bent round by her side Thus in time the tail becomes quite askew and is a tolerable guide to the length of time the bird has been sitting Both sexes of an Australian kingfisher (*Tanysiptera sylvia*) have the middle tail feathers greatly lengthened and the female makes her nest in a hole and as I am informed by Mr R. B Sharpe these feathers become much crumpled during incubation

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We may now consider Mr Wallace's arguments in

males would in all or almost all cases, have been transmitted to the females unless the transference had been checked through natural selection I may here remind the reader that various facts opposed to this view have already been given under reptiles amphibians, fishes and lepidoptera Mr Wallace rests his belief chiefly but not exclusively as we shall see in the next chapter on the following statement[9] that when both sexes are coloured in a very conspicuous manner the nest is of such a nature as to conceal the sitting bird but when there is a marked contrast of colour between the sexes the male being gay and the female dull-coloured the nest is open and exposes the sitting bird to view This coincidence as far as it goes certainly seems to favour the belief that the females which sit on open nests have been specially modified for the sake of protection but we shall presently see that there is another and more probable explanation namely that conspicuous females have acquired the instinct of building domed nests oftener than dull-coloured birds. Mr Wallace admits that there are as might have been expected some exceptions to his two rules, but it is a question whether the exceptions are not so numerous as seriously to invalidate them

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[8] Mr Ramsay in *Proc Zoolog Soc* 1868, p. 50.

[9] *Journal of Travel*, edited by A. Murray vol. i, 1868, p. 78.

n realed r l ly t t le ta l be ng lull blu bar led th black wl l t tl t of tl f n l is brown w th l lack l l ars so tl t l r tl e tail d ff s in col r t t tl two e m e actly the me n ann r as tl wl ole 1 per surface in tl e two se f C rci t

W tl 1 r t wl l l k wise bu l l m l l s we f l nal k us cases t t n t f tl pecı s l th se c b ll tly col ured an l m l y l gu l lle t t n t a f w peci tl e r ales e col ed tl r m re vividly tl an tl f l c e y d ff r ntly fr t tl t 11 l des tl t gly m k l l ff r c e tl wl l u der surface f tl t l k g l ry (*l p a t f l l t*) sc l t f tl f t l s

1

tusted tl e co cl o s t ting ual selectio t g th r th q ıal or nearly eq al al rtan by b tl se l v t d ı ectl let rm ed tl e man f n d ficat n f wl l g l l

wl

f males. Tl g f t fact f r gr diff re ces col m t be cco ted f l v f some f tl t th l l t k t be from tl first l t l n t n mns to w tl sam se as t n ha dly l mai t l l th t th se d ff e pec ally wh v t l ght, serv as prot ect t tl f l t Th all tl pec tl pl l l g p f (th t g l ld l l an l M G ld t k figu f b tl f tw t fi pec s, all f l l w tl part l ep- t n, tl se diff som tim l gl tl so tim p l ol —tl n l

Agai m tl g t gro 1 f tl e woox pe s tl sc s r g n r lly ly al k b t tl *M g p al d* all tl se parts of tl l ad eck, l b a t wl l a e r mso i tl m l a p l l ro n in tl e f mal A l oodpeck rs tl l ad f tl n al l right so wl l t tl t f tl e f male 1l t occ ed t e tl t thi col u m gl t poss l ly n k tl e f l l g rı lly co p wl l p tl l ad t f tl l l co taıng g l r t d c sequ tly th t tl l accord w tl M W l lace b l f l ad l ee cl m ted Tl w t gtl d by wl t M ll b tat w tl pect t *I d p s lott* n m ly th t tl r f l l k tl v r g m l h

f th pec tl se eq ll l nll t and thus l M W llace l l l l good b t som f th A t l pec th ol rs f tl f m l th l d that th se f tl m l and 1 l nd dly-col ed pec tl se d ff m cl tl t

f tl mal is b lted w tl black Ag m Carc t tl d ff ce b twee tl consp tl m l tl 1 pe rfac d ll bl banded tl black, tl l face be g 1 rtl f -col ed and tl cl red also t tl l ad tl f mal th ppe face is edd h l w l anded tl bl ck d th l fac h t w tl bl k n k g It t ting fact as l w g l w tl sam pec l t l f se l col g ft l t rise all ed f rm th t n th pe f D l tl m l l ff rs f m tl f

tl f ll g co d r t ns d thi tr m ly d btf l tl mal tak a f l l t 1,[20] d w ld b tl alm 1 ll posed to l g botl se f mai

See h *M nog 1 f th T g d* l ted t Nam ly Cyanal y n. G uld *H dbook f the B ds f Aust alia,* I. ı, p. 133 see also pp 130 136

ing twenty eight b nn * Nor is genus colour

sexes and the nature of the nest constructed Thus the male house sparrow (*Passer domesticus*) differs much from the fe male the male tree parrow (*P montanus*) hardly at all and yet both buil l well-concealed nests The two sexes of the common fly catcher (*Muscicapa grisola*) ... n cr ... and both sexes build in holes or conceal their nests The female blackbird (*Turdus merula*) differs much the female ring-ouzel (*T torquatus*) dif fers less and the female common thrush (*T musicus*) hardly at all from their re pective males yet all build open nests On the other hand the not very distantly allied water ouzel (*Cinclus aquaticus*) builds a domed nest and the sexes differ about as much as in the ring ouzel The black and red grouse (*Tetrao tetrix* and *T scoticus*) build open nests in equally well concealed spots but in the one pecies the sexes differ greatly and in the other very little

Notwithstanding the foregoing objections I cannot doubt after reading Mr Wallace s ex cellent essay that looking to the birds of the world a large majority of the pecies in which the females are conspicuously coloured (and in this case the males with rare exceptions are equally con picuous) build concealed nests for the sake of protection Mr Wallace enumer ates [2] a long series of groups in which this rule holds good but it will suffice here to give as instances the more familiar groups of king fishers toucans trogons puff birds (Capi tonidæ) plantain-eaters (Musophagæ wood peckers and parrots Mr Wallace believes that in these groups as the males gradually acquired through sexual selection their brilli ant colours the e were transferred to the females and were not el

... g to this view their present manner of nesting was acquired before their present colours But it seems to me much more probable that in most cases as the females were gradually rendered more and more bril liant from partaking of the colours of the male they were gradually led to change their in stincts (supposing that th ... lt g

Audubon s account of the differ ences in the nests of the same pecies in the northern and southern United State [3] will feel any great difficulty in admittin that birds either by a change (in the strict sense of the word) of their habit or through the natural selection of so-called pontaneous vari ations of instinct might readily be led to modify their manner of nesting

This way of viewing the relation as far as it holds good between the bright colours of fe male birds and their manner of nesting re ceives some support from certain cases occur ring in the Sahara Desert Here as in most other de erts various birds and many other animals have had their colours adapted in a wonderful manner to the tints of the surround ing surface Nevertheless there are as I am informed by the Rev Mr Tristram some curious exceptions to the rule thus the male of the *Monticola cyanea* is con picuous from his bright blue colour and the female al ... equall ... and ... of D ... the e two species are far from receiving pro tection from their colours yet they are able to survive fo they have acquired the habit of taking refuge from danger in holes or crevices in the rock

With re pect to the above group in which the female are conspicuously coloured and build con ... al ... not ... necessary to suppose that a h ... had its nidifying instinct ... ally modified ... also that the ... rly p ... s of a l g ... up were

[1] I have consulted on this subject M ... y *Brit* ... p ... *con* ... ings ... co ... Hutt ... 2 p ... y ... Mu ... Musc ... p 2 p ... d 3 p ... d Cyp-selu ... females ... birds ... be ... s ... d ... s con p ... us ... g ... Muscicapa lba ... m jor ... d ... l ur ... pupa ... cus, 4 p ... as, Mered ... nd Merops, *J* ... *nal of T* ... l ed ... d by A Murray v l p 8

... m ... y ... *al H* ... *phy Soc* ... w ... ts of Birds by ... d *Ila Soc* ... *Ill* ... 1860 ... 45

Therefore if oth pecies f G llus and Columba were d mest cated nd aried, it ould ot be rash t pred t tl t imilar rules of sexual similarity and diss milarit d pend ing th f rm f transmissi n, w uld hold good in both cases. In like mann r th same form of transmission has g rally pre ailed unde natur thr gh t the same gro ps, al though marked excepti ns t this rule occur Thus thin th sam family o n g nus, the sexes may be id t cally alike, r rv dif ferent in colour In tances ha already been gi en in the sam g s, as w th parr ws, fly catchers, thrush and grouse In th family f pheasants th se es f almost ll the pecies are nderf lly dissim lar l t are q te alike in th eared pheasant *C os ptilo rit m* In t o species f Chloephaga, g nus f g ese the male cann t be di ti guished f m th f h wl Lt tw tl rs, th

him more or less completel H re protecti n can hardly ha com t play Mr Blyth forms m that th f m les f *Oriol melano-* f m ll ed pecies, wh n uf

prese ts an int rmedi te garb which is ul timat l hanged f th sam li ry as that of th mal So again th f mal *Falco pere-g* acquires h bl pluma m re l ly than th mal Mr Swinhoe tates that with on of the dron hrikes (*Dicrurus macro-cr*) th mal whilst almost nestling, moults hi soft b w pl mag and becomes f iform glossy gree h black b t th fe-male reta ns f lo t m th whit striæ and pots th llars f th rs and does t complet l assum th unif rm black col-ou of th mal f three ar Th sam cellent observ remarks that in th pri g f the second year th f m l poo bill (Pl ta. l China resembl th mal f th first ear and that ppare tly t is n t until th

third pri g that l cquires tl e sam adult plum ge as that possessed l tl mal t a much earl er ge Tl e f nal *B mby lla carol nensis* differs ry littl from th male, l l lk beads f red

male In the mal of an l u a.. a. (*Pal rn j a c*) th pper mand ble i l est y uth, but n the fe-

all respects. B th se f U w u t ultimately f rn hed w th tuft f bri tl on mo- ol l b rds th t ft is

f to n

These cases mu t n t be confounded w th those wh re diseased old f mal al n mall ass m masculin charact rs, n r w th those wh f rtil f males, whilst y u g e q ir th hara t rs f th male thr gh riati or som unkn w cause[1] B t all these cases ha so much in comm n that th y d pe d accordi g t the hypothesis of pan g esis, n g mmules d ri ed f m each part f th mal be g p esent, th gh lat nt, n th f mal th d l pm nt foll wing on som light chang n the electi affinities of h constit nt tiss es.

A f w w rds must be added n hanges f plumag in lati n to th season of th year

[1] Wh th mal courts th f mal these m m ts are b ted, d are sh w fl t great d n t th tstret hed w gs A Le th

[2] The *Ibis* vol vi., 1864 p 122.

ari us instances with La us, Rut cilla, Linaria, d A as Aud bo has lso recorded milar case (*Or tholog Biogr phy* ol p. 519) with *Pyr g a*.

species have their heads of an equally bright crimson in other species the difference between the sexes in the amount of scarlet is so slight that it can hardly make any appreciable difference in the danger incurred and lastly the colouring of the head in the two sexes often differ slightly in other ways

The cases as yet given of slight and graduated differences in colour between the males and females in the groups in which as a general rule the sexes resemble each other all relate to species which build domed or concealed nests But similar gradations may likewise be observed in groups in which the sexes as a general rule resemble each other but which build open nests

As I have before instan ... an ... ig ... e ... ie

... nces in plumage between the sexes are of the same general nature as the occasionally greater differences ... good ...

... t ... manner in the two sexes Similar cases may be observed with parrots and pigeons The differences in colour between the sexes of the same species are also of the same general nature as the differences in colour between the distinct species of the same group For when in a group in which the sexes are usually alike the male differs considerably from the female he is not coloured in a quite new style Hence we may infer that within the same group the special colours of both sexes when they are alike and the colours of the male when he differs slightly or even considerably from the female have been in most cases determined by the same general cause this being sexual selection

It is not probable as has already been remarked that differences in colour between the sexes when very slight can be of service to the female as a protection Assuming however that they are of service they might be thought to be cases of transition but we have no reason to believe that many species at any one time are undergoing change Therefore we can hardly admit that the numerous females which differ very slightly in colour from their males are now all commencing to become obscure for the sake of protection Even if we con ... ler somewhat more marked sexual differences, is it probable for instance, that the head of the female chaffinch —the crimson on the breast of the female bullfinch —the green of the female greenfinch —the crest of the female golden crested wren have all been rendered less bright by the slow process of selection for the sake of protection? I cannot think so and still less with the slight difference between the sexes of those birds which build concealed nests On the other hand the differences in colour between the sexes whether great or small may to a large extent be explained on the principle of the successive variations, acquired by the males through sexual selection, having been from the first more or less limited in their transmission to the females. That the degree of limitation should differ in different species of the same group will not surprise any one who has studied ...

As far as I can discover there are few large groups of birds in which all the species have both sexes alike and brilliantly coloured but I hear from Mr Sclater that this appears to be the case with the Musophagae or plantain eaters Nor do I believe that any large group exists in which the sexes of all the species are widely dissimilar in colour Mr Wallace informs me that the chatt ...

... r ... ast and th ...

... throughout ... and thus, from ... the fluctuating nature of inheritance ... circumstance But that they ... large ... prevail with all ... animal ... surprising ... the fowl ... produced a great number of breeds and ... the sexes generally differ in plumage so that it has been noticed as an unusual circumstance when in certain sub-breeds they resemble each other On the other hand the domestic pigeon has likewise produced a vast number of distinct breeds and sub-breeds and in these with rare exceptions the two sexes are identically alike

^[?] Gould Handbook of the Birds of Australia ... ii pp 109 149

... See ... to the ... ffect ... and ... nder Domestication, ... p. ...

CHAPTER XVI

BIRDS—*Concluded*

We must now consider the transmission of characters, as limited by age, in reference to sexual selection. The truth and importance of the principle of inheritance at corresponding ages need not here be discussed, as enough has already been said on the subject. Before giving the several rather complex rules or classes of cases, under which the differences in plumage between the young and the old, as far as known to me, may be included, it will be well to make a few preliminary remarks.

With animals of all kinds when the adults differ in colour from the young, and the colours of the latter are not, as far as we can see, of any special service, they may generally be attributed, like various embryological structures, to the retention of a former character. But this view can be maintained with confidence only when the young of several species resemble each other closely and likewise resemble other adult species belonging to the same group; for the latter are the living proof that such a state of things was formerly possible. Young lions and pumas are marked with feeble stripes or rows of spots, and as many allied species both young and old are similarly marked, no believer in evolution will doubt that the progenitor of the lion and puma was a striped animal, and that the young have retained vestiges of the stripes, like the kittens of black cats, which are not in the least striped when grown up. Many species of deer, which when mature are not spotted, are whilst young covered with white spots, as are likewise some few species in the adult state. So again the young in the whole family of pigs (Suidae) and in certain rather distantly allied animals, such as the tapir, are marked with dark longitudinal stripes; [illegible] character apparently derived from an extinct progenitor and now preserved [illegible] the young alone. In all such cases the [illegible] had their colours changed [illegible] the [illegible] whilst the young have remained [illegible] but little altered, and this has been effected through the principle of inheritance at corresponding ages.

This same principle [illegible] belonging to [illegible] groups, in which the young closely resemble [illegible] and differ from their respective adult parents. The young

of almost all the Gallinaceae and of some distantly allied birds such as ostriches, are covered with longitudinally striped down; but this character points back to a state of things so remote that it hardly concerns us. Young crossbills (Loxia) have at first straight beaks like those of other finches, and in their immature striated plumage they resemble the mature redpole and female siskin, as well as the young of the goldfinch, greenfinch, and some other allied species. The young of many kinds of buntings (Emberiza) resemble one another and likewise the adult state of the common bunting, E. miliaria. In almost the whole large group of thrushes the young have their breast spotted—a character which is retained throughout life by many species, but is quite lost by others, as by the Turdus migratorius. So again with many thrushes, the feathers on the back are mottled before they are moulted for the first time, and this character is retained for life by certain eastern species. The young of many species of shrikes (Lanius), of some woodpeckers, and of an Indian pigeon (*Chalcophaps indica*), are transversely striped on the under

[illegible]

[illegible] genus, Dendrocygna, which [illegible] mature [illegible] similar [illegible] will hereafter be given in regard to certain herons. Young black grouse (*Tetrao tetrix*) resemble the young as well as the old of certain other species, for instance the red grouse or T. [illegible] Finally, as Mr. Blyth, who has attended closely to this subject, has well remarked, the natural affinities of many species are best exhibited in their immature plumage; and

[1] I regard to thrushes, shrikes, and woodpeckers, see Mr. Blyth, in Charlesworth's *Mag. of Nat. Hist.* vol. [illegible] 183, p. 304; also foot-note to his translation of Cuvier's *Règne Animal*, p. 159. I give the case of Loxia on Mr. Blyth's information. On thrushes, see also Audubon, *Ornith. Biog.* vol. [illegible] p. 195. On Chrysococcyx and Chalcophaps, Blyth, as quoted in Jerdon's *Birds of India*, vol. [illegible] p. 485. On [illegible] is, Blyth, *Ibis*, 1867, p. [illegible]

From reasons formerly assigned there can be little doubt that the elegant plumes, long pendant feathers, crests, &c., of egrets, herons, and many other birds, which are developed and retained only during the summer, serve for ornamental and nuptial purposes, though common to both sexes. The female is thus rendered more conspicuous during the period of incubation than during the winter; but such birds as herons and egrets would be able to defend themselves. As, however, plumes would probably be inconvenient and certainly of no use during the winter, it is possible that the habit of moulting twice in the year may have been gradually acquired through natural selection for the sake of casting off inconvenient ornaments during the winter. But this view cannot be extended to the many waders, whose summer and winter plumages differ very little in colour. With defenceless species, in which both sexes, or the males alone, become extremely conspicuous during the breeding season,—or when the males acquire at this season such long wing or tail feathers as to impede their flight, as with Cosmetornis and Vidua,—it certainly at first appears highly probable that the second moult has been gained for the special purpose of throwing off these ornaments. We must, however, remember that many birds, such as some of the birds of paradise, the Argus pheasant and peacock, do not cast their plumes during the winter; and it can hardly be maintained that the constitution of these birds, at least of the Gallinaceæ, renders a double moult impossible, for the ptarmigan moults thrice in the year.[11] Hence it must be considered as doubtful whether the many species which moult their ornamental plumes or lose their bright colours during the winter have acquired this habit on account of the inconvenience or danger which they would otherwise have suffered.

I conclude, therefore, that the habit of moulting twice in the year was in most or all cases first acquired for some distinct purpose, perhaps for gaining a warmer winter covering; and that variations in the plumage occurring during the summer were accumulated through sexual selection, and transmitted to the offspring at the same season of the year; that such variations were inherited either by both sexes or by the males alone, according to the form of inheritance which prevailed. This appears more probable than that the species in all cases originally tended to retain their ornamental plumage during the winter, but were saved from this through natural selection resulting from the inconvenience or danger thus caused.

I have endeavoured in this chapter to shew that the arguments are not trustworthy in favour of the view that weapons, bright colours, and various ornaments, are now confined to the males owing to the conversion, by natural selection, of the equal transmission of characters to both sexes into transmission to the male sex alone. It is also doubtful whether the colours of many female birds are due to the preservation, for the sake of protection, of variations which were from the first limited in [illegible] transmission to the female sex. But it will

[11] See Gould's *Birds of Great Britain*.

the young and old

p co cerned is

hib ted till m re learly n certain anomalou case thus the mal of *H liothrix a l ta* (on f th humming b rd) diff rs con p cu ou ly fr m th f mal n ha g a pl did g re t and fin ar t fts, b t th fem le is re wh p much l g r t d than

th respects, incl di g th so that tl tail f th mal ctually b co h rt as h caches m tur ty which is most un al circumstance Again th pl mag of A (*Merg m g user*) s

f thersm b occurs, as far I kn w in any th b rd, tl crest f th d lt mal th gh l road tl n tl f m l cons l rabl l rt be

lo g. N semil tl d lt f mal so th t tl r est are t ll f gre t r l gtl tl gh na row tl an in th ad lt mal

Wl th y g and tl f m les l selv re sem l tl d botl diff from th ma ma an t l l na g

dist t co tri For w n se r prese tati e pecies th ad lt males h e und g ne a erta n am nt of cl ge and can be d tinguished the f males and the yo g f om tl distinct countri be ng nd ting ish able and therefore bsol tely unchanged Th the case with certain Indian chats (Thamn b) w th certain h n y k rs (Nectarinia) hrik s (Tephrodornis) certain ki gfi h (Tanysiptera) K l j ph asa ts (G ll phasi) and tree part dges (Arboricol)

I som an l g u cases, mely w th b rds ha g d ffere t umm r d w nt r pl m g b t w th tl e t o se s n arly al k cer ta l sely ll ed pecie can as ly be d ti gui l ed in th s mm r pl al p l m g y t are nd t g ish able n tl w nte a w ll as in tl mm ture pl g Tl tl case w th som f th l sely ll l Ind an w g ta ls M t cillæ M S hoe[4] nf rm e t tree pec es f A leola, gen of l r

bl tl ad lt tl w t dress. This case is all th m re t re t g l ce se w tl two th spec f Ardeola botl se s ta n d p tl w t and mm n arly tl e sam

bee partially l t by th ad lt m l f m som explai ed ca se and tran tted n their liminished tat to th m l ff p n g alo h arri ed t th corre po d g g f mat rit Th belief th t n th p se t lass th mal al has bee mod fied, as f as tl diff ces between th m l and tl f male

seasons, p to f th g w re col red In all th se cases, th n pt l pl m g wl l w m as m was ngi lly acq red b tl ad lt mal d ring th breedin ason, and t ans m tted to th ad lts f b th se t th co po ding seaso has been mod fied wh lst tl w t and mm t plum g h been l ft h ged.

less b llia tl coloured l som species of D cel the les ha blue tails, d the f males bro nes d M R. B Sharpe f rms m that th tail of tl ung mal f *D g ud howd* is t first bro M G uld has described (*Ibid* L pp 14 & 37) th se es d th y g of certa bla k cockatoos d of th ki g lory th whi h th same rule prevails. Also J rd (*B ds f I dia*, L p 260) the *Palæorn osa* hich the y g m re l ke th f mal than th mal See Aud bo (*O hologi al Biogr phy* l p 4) th tw se es nd the y g of *Col mba passeri* I this nformatio t M G uld h he ed he be pecim ns see lso h *Introduction to th Trochilidæ* 1861 p. 120

Macgillivray *Hist. Brit. B ds* L pp 207 214

Mr Blyth, in *Ibis* January 1861 p 25

as the true affinities of all organic beings depend on their descent from a common progenitor this remark strongly confirms the belief that the immature plumage approximately shews us the former or ancestral condition of the species

Although many young birds belonging to various families thus give us a glimpse of the plumage of their remote progenitors yet there are many other birds, both dull coloured and bright-coloured in which the young closely resemble their parents In such cases the young of the different species cannot resemble each other more closely than do th [illegible] nor [illegible] ien [illegible] he [illegible] in so far that when the young and the old are coloured in the same general manner throughout a whole group of species it is probable that their progenitors were similarly coloured

We may now consider the classes of cases under which the differences and resemblances between the plumage of the young and the old in both sexes or in one sex alone may be grouped Rules of this kind were first enounced by Cuvier but with the progress of knowledge they require some modification and amplification This I have attempted to do as far as the extreme complexity of the subject permits from information derived from various sources but a full essay on this subject by some competent ornithologist is much needed In order to ascertain to what extent each rule prevails, I have tabulated the facts given in four great works namely by Macgillivray on the birds of Britain Audubon on those of North America, Jerdon on those of India and Gould on those of Australia I may here premise first that the several cases or rules graduate into each other and secondly that when the young are said to resemble their parents it is not meant that they are identically alike for their colours are almost always less vivid and the feathers are softer and often of a different shape

Rules or Classes of Cases

I When the adult male is more beautiful or conspicuous than the adult female the young of both sexes in their first plumage closely resemble the adult female as with the common fowl and peacock or as occasionally occurs they resemble her much more closely than they do the adult male

II When the adult female is more conspicuous than the adult male as sometimes though rarely occurs the young of both sexes in their first plumage resemble the adult male

III When the adult male resembles the adult female the young of both sexes have a peculiar first plumage of their own as with the robin

IV When the adult male resembles the adult female the young of both sexes in their first plumage resemble the adults, as with the kingfisher many parrots, crows hedge-warblers

V When the adults of both sexes have a distinct winter and summer plumage whether or not the male differs from the female the young resemble the adults of both sexes in their winter dress or much more rarely in their summer dress or they resemble the females alone Or the young may have an intermediate character or again they may differ greatly from the adults in both their seasonal plumages.

VI In some few cases the young in their first plumage differ from each other according to sex the young males resembling more or less closely the adult males and the young females more or less closely the adult females.

Class I In this class the young of both sexes more or less closely resemble the adult female whilst the adult male differs from the adult female often in the most conspicuous manner Innumerable instances in all Orders could be given it will suffice to call to mind the common pheasant duck and house sparrow The cases under this class graduate into others. Thus the two sexes when adult may differ so slightly and the young so slightly from the adults that it is doubtful whether such cases [illegible]

ever are few or at least are not strongly pronounced in comparison with those which come strictly under the present class

The force of the present law is well shewn in those groups in which as a general rule the two sexes and the young are all alike for when in these groups the male does differ from the female as with certain parrots, kingfishers, pigeons &c the young of both sexes resemble the adult female We see the same fact ex

See for instance Mr Gould's account (*Handbook of the Birds of Australia* vol i p 133) of Cyanalcyon (one of the Kingfishers) in which, however, the young male though resembling the adult female is

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M g ll y H tory of British B d l.
pp 172-174

said
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In add t n t th ffects of the part l

The question naturally arise how is it that in these latter cases the winter plumage of both sexes and in the former cases the plumage of the adult females as well as the immature plumage of the young have not been at all affected The specie which represent each other in distinct countries will almost always have been exposed to somewhat different conditions but we can hardly attribute to this action the modification of the plumage in the males alone seeing that the females and the young though similarly exposed have not been affected Hardly any fact shews us more clearly how subordinate in importance is the direct action of the conditions of life in comparison with the accumulation through selection of indefinite variation than the surprising difference between the sexes of many birds for both will have consumed the same food and have been exposed to the same cl n t

in the whole family of the Gallinaceæ the females for instance of the common and Japan pheasant and especially of the gol l an l Amherst pheasant—of the silver pheasant and the wild fowl—resemble one another very closely in colour whilst the males differ to an extraordinary degree So it is with the females of most of the Cotingidæ Fringillidæ and many other familie There can indeed be no doubt that as a general rule the females have been less modified than the males Some few birds however offer a singular and inexplicable exception thus the females of *Paradisea apoda* and *P. papuana* differ from each other more than do their respective males [1] the female of the latter species having the under surface pure white whilst the female *P. apoda* is deep brown beneath So again as I hear from Pro-

both sexes or from their constitutional differences chiefly on one sex We see only that this is subordinate in importance to the accumulated results of selection Judging however from a wide spread analogy when a species migrates into a new country (and this must precede the formation of representative species) the changed conditions to which they will almost always have been exposed will cause them to undergo a certain amount of fluctuating variability In this case sexual selection which depends on an element liable to change—the taste or admiration of the female—will have had new shades of colour or other differences to act on and accumulate and as sexual selection is always at work it would (from what we know of the results on domestic animals of man unintentional selection) be surprising if animal inhabiting separate h trict which c n n ver cro s and tl us l lc l tl en newly acquired h racter w re not af ter a sufficient l p e of ti ne liff rently m h fied The emarks lik ise apply to the nuptial or summer plumage whether c nf l to the male or common to both sexes

Although the f mal of tl e d c clo ly allied or representative p c e tog tl r with their young differ hardly at all from n n other so that the male alone can be distinguished yet the f males f most peci with in the ame genus obviously differ from each other The differences however are rarely as great as between the males We see this clearly

pears to have partially retained an immature condition of plumage for at first sight le might be taken for the young of the Maurtian peci These differences may be compared with those inexplicable one which occur independently of man s selection in certain sub breeds of the game fowl in which the females are very different whilst the males can hardly be distinguished

As I account so largely by sexual selection for the differences between the males of allied pecie how can the differences between the f males be accounted for in all ordinary case We need not here consider the species which belong to distinct gen ra for with these adaptation to differ nt habits of life and oth r ag ncie will hav con e n t play In regard to the differ nc betwe en the female tl in the same genus it appears to m alm t certain aft r looking through variou larg grou that the l i f agent has l een the g ater or less tra f r nce t tl f mal f tl charact ac qu l l v tl mal tl g l sexual sel ti n In tl v ral Briti h fu l es tl tw sex s differ ither v ry l gl tly o ral ly an l f w on l alf el ro ac

[1] Wallace The Malay Archipelago 1869 p 394

The ... described ... the coloured figures by M F ... n *Ib* 1860 p 27

... p 251

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p tridg s, q ails, gu n a fowls, & in wh ch
tl col ur f th pl ma have been larg ly
t ansf rred from tl e male t the female are
brill ntly col red Th s w ll emplified
w th th pl easants, n which th mal is g n
ally so m ch m e b lliant than th f mal
b t w tl th Eared and Cheer pheasants
(*C os pt lon rit m* and *I has s wall ch*)
th se l sel resembl each oth r a d th ir
colo rs are d ll. W m y g so far as t bel e e
th t if any part f th plum ge in tl e males of
th se tw pl asants had been brill antly col
ured, t w uld n th been t ansf red to the
f males. Th se fact st gly support Mr.
Wallace w th t with b rds which are x
posed to much dan r d ring nc b t n, the
transf e ce of brigl t col ur from tl e male to
th f mal has been checked through natu al
h f g t that

pe
dang and w ld g ne ally h been d
troyed th ld and m re u males, n
tl tl hand if th y red in a like mann

g use l as acquired his fi black pl mag
th h f ked and twardly-cu led tail
f th rs b t f tl se h act rs th has
l ardly bee any transf re ce t th f mal
cepting th t sh l w h tail trace f
th urved f k.

tints w ld n t ha b n transm tted to th
f m les On the the hand o nam ts f a
less consp u us kind uch as th se po sessed
by tl Eared and Chee ph asa ts, w ld n t
h bee dang ro s, and if th y ppeared
duri g arly y th, w uld g nerally ha e been
transmitted to b th se

In additi n to th effects of the partial

Macgillivray *History of British B d* ol i, pp 172-174

transference of characters from the males to the females some of the differences between the females of closely allied species may be attributed to the direct or definite action of the conditions of life [1] With the males any such action would generally have been masked by the brilliant colours gained through sexual selection but not so with the females Each of the endless diversities in plumage which we see in our domesticated birds is of course the result of some definite cause and under natural and more uniform conditions some one tint assuming that it was in no way injurious would almost cert

change of colour thus induced uniform in character

No one doubts that both sexes of many birds have had their colours adapted for the sake of protection and it is possible that the females alone of some species may have been modified for this end Although it would be a difficult perhaps an impossible process as shewn in the last chapter to convert one form of transmission into another through selection there would not be the least difficulty in adapting the colours of the female independently of those of the male to surrounding objects through the accumulation of variations which were from the first limited in their transmission to the female sex If the variations were not thus limited the bright tints of the male would be deteriorated or destroyed Whether the females alone of many species have been thus specially modified is at present very doubtful I wish I could f ll

to the female as a protection would be at once obliterated instead of being lost simply by not being selected or from free in tercros ing or from b ing eliminated when transferred to the male and in any way injurious to him Thus the plumage of the female would be kept constant in character It would also be a relief if we could admit that the obscure tints of both sexes of many birds had been acquired and preserved for the sake of protection —for example of the hedge warbler or kitty wren (*Accentor modularis* and *Troglodytes vulgaris*) with respect to which we have no sufficient evidence of the action of sexual selection We ought however to be cautious in concluding that colours which appear to us dull are not attractive to the females of certain species we should bear in mind such cases as that of the common house sparrow in which the male differs much from the female but does not exhibit any bright tints. No one probably will dispute that many gallinaceous birds which live on the open ground have acquired their present colour at least in part for the sake of protection We know how well they are thus concealed we know that ptarmigans, whilst changing from their winter to their summer plumage both of which are protective suffer greatly from birds of prey But can we believe that the very slight differences in tints and markings between for instance the female black grouse and red grouse serve as a protection Are partridges as they are now coloured better protected than if they had resembled quails? Do the slight differences between the females of the common pheasant the Japan and gold pheasants serve as a protection or might not their plumage have been interchanged with impunity From

rences are beneficial For myself I will only say that I am not convinced

Formerly when I was inclined to lay much stress on protection as accounting for the duller colours of female birds it occurred to me that possibly both sexes and the young might aboriginally have been equally bright coloured but that sub e quently the females from the danger incurred during incubation and the young from being inexperienced had been rendered dull as a protection But this view is not supported by any evidence and is not probable for we thus in imagination expose during past times the female and the young to danger from which it has subsequently been necessary to shield their modified descendants We have

On the supposition that the females and the young have partaken during each stage of the process of modification of a tendency to be as brightly coloured as the males, it is also a somewhat strange fact that the female have never been rendered dull coloured without the young participating in the same change for there are no instances as far as I can discover of species with the females dull and the young bright coloured

1 See on this subject ch p x the Variation of Animals and Plants under Domestication.

partial e ception how r ff red by tl e y ung f certain woodpeck rs, f th ha e tl whol upper part f the l ead tinged th ed luch afterward tl r decreases int mere circul r red l n n tl ad lts of both sex s, r qu t d sapp n tl e ad lt f

mal t the l t period l ts bee l rese ed and tl t m t ll f tl se art t in t the l t p riod f l f t h h tl y appeared h been from the first transmitted ly t th ad lt m l ff pring An n ti bright n occ rr g in the f mal th g w ld h b f o se ce t tl m nd w ld t l bee selected and m reo f dang ro s, w ld h b l min ted Th th f mal and th y g will th l bee l ft mod fied (as m ch m re comm) w ll l bee part ally mod fied by rece g tl ro gh tran f re ce f m tl mal som f l res n t B th ha p l ps

fied will l t xhib t l ffects. Tl ese h g and all tl w ll l bee k pt if m by th f t re s f m v nd d ls I so cas pec lly w th g d b rd th f males an l tl g m y poss l l ha bee mod f ed d pe d tl f tl m l s, f th sak f p tect so a t l acquired th m l ll-col ed pl g

Cl. II If he the ad lt fem l m con p th the adult male th y g f both the fi t pl m y emble the adult male.—Thi class actl tl rs f tl last f th f mal are h re bright col ed m consp uo than tl l d tl g, as far as th ar kn esembl tl ad lt m l t d f th ad lt f m l B t tl l ff re ce l twee tl l so gre t as w th many b rd in th first clas f tl ase re compar ti l M Wall ce l first lled tt t t th g la rel t n hi l xi ts betwee th l ss l g l t col rs f tl m l and th pe f rm g tl d t f incub t l gr. t t ss

on tl is point as a c uc1 l te t that obsc re col rs l l een acq ired f r tl e sake of protection d ring the pe od f i t g l d ff r e t ew see to me n o e prol able As tl e ase are rion and n t nu rous, I w ll l n fl g e ll th t l l bee al l t f d

It secti n f tl e g n Turn x qu l l t tl f le is invariably larg r than

mai
i g i k g -cocks. A mal bird re xposed by tl E gl l b rd-cat l fo a decoy ea t p rd to tch tl r m l by e t ing tl ri l v so tl f mal s of this T rnix ar pl ed i I d a W l n thu e posed tl e f m le soo b gi tl r l d p rri g ll wl l an h b ard l w ff t l any fem l w tl l t run y dly to tl pot and comm ce fighting w th th caged b rd In th w y from tw l e to tw nty b rd all breed f males m y b caught tl cours of a ingle d y Tl nat es assert that the f m l aft l y g th r ggs assoc t in flocks and lea tl m les to sit th m Tl re s n

th ad lt mal

Tl f m l f th tl re pec f pai ted sn pe (Rl yn hœa, fig 6) are n t nly larg b t m h m re ri hl col ured than tl e m l W tl all th b rd n l h the tracl d ff rs in t t re tl tw se es t m re d l ped and compl th m l th in tl f mal b t n th I h ha s

Aud bon, *Ornith. B og phy* l p 193 Macgill ray *History f Brit h B ds* l p 85 See also th case bef re gi of *Ind p cu ca lotta.*

W tm nster Review Jul 1867 and A Murray *J ial f T* l, 1868 p 83

F th A tral pec see G uld *H nd book* d l pp 1 8, 180 186 d 188 I th Brit h Museum pecim ns f th Aust al pl d (*T dionom t q t*) m y b see

transference of characters from the males to the females some of the differences between the females of closely allied species may be attributed to the direct or definite action of the conditions of life.[11] With the males any such action would generally have been masked by the brilliant colours gained through sexual selection but not so with the females. Each of the endless diversities in plumage which we see in our domesticated birds is of course the result of some definite cause and under natural and more uniform conditions some one tint assuming that it was in no way injurious would almost certainly sooner or later prevail. The free intercrossing of the many individuals belonging to the same species would ultimately tend to make any change of colour thus induced uniform in character.

No one doubts that both sexes of many birds have had their colours adapted for the sake of protection and it is possible that the females alone of some species may have been modified for this end. Although it would be a difficult perhaps an impossible process as shewn in the last chapt ... ne form ... lection ... adapt ... ing colours of the female independently of those of the male to surrounding objects through the accumulation of variations which were from the first limited in their transmission to the female sex. If the variations were not thus limited the bright tints of the male would be deteriorated or destroyed. Whether the females alone of many species have been thus specially modified is at present very doubtful. I wish I could follow M ... ... l ... o t e female as a protection would be at once obliterated instead of being lost simply by not being selected or from free intercrossing or from being eliminated when transferred to the male and in any way injurious to him. Thus the plumage of the female would be kept constant in character. It would also be a relief if we could admit that the obscure tints of both sexes of many birds had been acquired and preserved for the sake of protection,—for example of the hedge warbler or kitty wren (*Accentor modularis* and *Troglodytes vulgaris*) with respect to which we have no sufficient evidence of the action of sexual selection. We ought, however to be cau ... ... r ... nd such cases ... sparrow in which the male differs much from the female but does not exhibit any bright tints. No one probably will dispute that many gallinaceous birds which live on the open ... ... are ... t ... concealed we know that ptarmigans, whilst changing from their winter to their summer plumage both of which are protective suffer greatly from birds of prey. But can we believe that the very slight differences in tints and markings between for instance the female black grouse and red grouse serve as a protection. Are partridges as they are now coloured better protected than if they had resembled quails? Do the slight differences between the females of the common pheasant the Japan and gold pheasants serve as a protection or might not their plumages have been interchanged with impunity. From ... ... ences are beneficial. For myself I will only say that I am not convinced.

Formerly when I was inclined to lay much stress on protection as accounting for the duller colours of female birds it occurred to me that possibly both sexes and the young might aboriginally have been equally bright coloured but that subsequently the females from the danger incurred during incubation and the young from being inexperienced had been rendered dull as a protection. But this view is not supported by any evidence and is not probable for we thus in imagination expose during past times the females and the young to danger from which it has subsequently been necessary to shield their modified descendants. We have also to reduce through a gradual process of selection the females and the young to almost exactly the same tints and markings, and to transmit them to the corresponding sex and period of life. On the supposition that the females and the young ... partaken during each stage of the process of ... life ... of a tendency to be as brightly coloured as the males, it is also a somewhat strange fact that the females ... have never been rendered dull coloured without the young participating in the same change, for there are no instances as far as I can discover of species with the females dull and the young bright ... ...

[11] See on this subject ch. p. x ... th ... of ... f ... males and Plants under Domestication.

have not been able to disco er wh th r with these species th oun resemble th ad lt males more closely than th ad lt f males for the compariso is some hat difficult to make on account of th double m ult.

Turning now t th ostrich Ord th male of the comm cassowary (*Cas arius galeatus*) would be thought by an n to be the f mal from his smalle size and from th ppendages and naked skin about hi head being much l ss bright coloured and I am inf rmed b M F t t tl t tl Zoological Gard ns, t is

male of one of the mus (*Dromæu rorat*) is consid rabl larg than the male and she possesses light top-knot b t is th rwise in distinguishable in pl mag Sh ppears, how eve to ha greater powe whe angry or otherwise excited of recting like turkey cock, the f ath rs of her neck and breast. She is usual th more courageou and p gilistic. The makes deep hollow guttural boom espe cially at night, soundin lik smal g n. Th male has slendere fram and is more docil

the young from their moth f as soon as she catches sight of h proge he becom violentl gitated and not th tand g th resistance of th fath ppears to use he t most ndea urs t destro th m Fo mo th afterwards t is unsaf t p t th parents together viole t quarrel being th ine tabl result in hich th f mal g n rall comes ff conquero [33] so that with this m w ha comp et re ersal not nl of the parent l and incubating instincts. b t f the us al moral qualities of the tw se es th f males bein sa age quarrelsome and nois th males gen tle and good The case ery different with the African strich, f the mal is somewhat larger than th f male and has fine p umes

with more tro gly contrasted colours ne e th less he undertakes the whole duty of incu bation.[34]

I will specif the few oth cases kn wn to me in which th f male is more conspicuou l coloured than the mal alth gh noth g is known also t tl e mann r of ncubati Witl th carnio ha k of the Falkland I land (*Milvag le curus*) I was much surprised to find by dissection that the indi iduals, which had all their tints trongly pronounced w tl tl cere and legs ange-coloured w re the ad lt f males whil t those w th d ller pl m ge and grey l gs were th mal s or tl e o ng In an Australian tree-creeper (*Cl macteris erythr ps*) th f mal diff rs from the mal in being adorned w th be t l, radiated ruf marki on th throat, the male ha ing this part q t plain " Lastl an A tral an night jar the f male alwa xceeds th male in ize and tl brilliance of her tints the males, n the otl hand ha e two wait spots on tl primaries m re conspicuous than in tl f male [37]

W thus see that the case in which f male b rds are more co spicu usly coloured than th males, w th tl ou g in thei immature pl mage resembling the adult males t ad of the adult femal s, as in tl previous class, are not n m ro s, though the are distrib t l n ari Ord rs The am unt of diff re ce also,

[33] The nati es of Ceram (Wallace *Malay Archipelago*, ol u., p. 1 0) assert that the male d female sit al ernately th eggs but this assertion, as M Bartlett thinks, ma be accounted for by the female visiting the nest t lay he egg

The Indian, April, 18 0 p. 124.

See the rece account of the habits of this bird under confinement, b M A. W Bennett, in *Land and Water* May 1868, p. 233.

[34] M Scl ter the ncubatio of the Struthiones,

what d her back is redder tha that of the male the head of the male is of rich dark bronzed colour d his back is clothed th finely pe cilled slate-coloured feathers, so that alt ether he may be considered as the more be tiful of the t o. H is larger and more pugnacious tha the female, and does ot sit the eggs. So that ll these respects this pecies comes under our first lass of cases b t Mr Sclater (*Proc ed g of the Zoological Society* 1866 p. 150) was much surprised to observ that the you g of both sexes, when abo t three mo ths ld, resembled in their dark heads nd necks th adult males, instead of the adult females so that t would ppear in this case that the f males ha been modified, whilst the males and the young have retained former state of pl mage.



FIG 62 *Rhy chæa c pe* (fr m Brehm)

tralis it is simple in the male whilst in the female it makes four distinct convolutions before entering the lungs[17] The female therefore of this species has acquired an eminently masculine character Mr Blyth ascertained by examining many specimens that the trachea is not convoluted in either sex of *R bengalensis* which species resembles *R australis* so closely that it can hardly be distinguished except by its shorter toes This fact is another striking instance of the law that secondary sexual characters are often widely different in closely allied forms though it is a very rare circumstance when such differences relate to the female sex The young of both sexes of *R bengalensis* in their first plumage are said to resemble the mature male[18] There is also reason to believe that the male undertakes the duty of incubation for Mr Swinhoe[19] found the females before the close of the summer associated in flocks as occurs with the females of the Turnix

The females of *Phalaropus fulicarius* and

is far from conspicuous According to Professor Steenstrup the male alone of *P fulicarius* undertakes the duty of incubation this is likewise shewn by the state of his breast feathers during the breeding season The female of the dotterel plover (*Eudromias morinellus*) is larger than the male and has the red and black tints on the lower surface the white crescent on the breast and the stripes over the eyes more strongly pronounced The male also takes at least a share in hatching the eggs but the female likewise attends to the young[20] I

[17] Gould's *Handbook of the Birds of Australia* vol. ii p 275

[18] *The Indian Field* Sept. 1858, p 3

[19] *Ibis* 1866 p 298

F r ... *B d* ... th t l ... serv t ... f th ... la g ... th y l w ... h gre t r l t ... y g w ... f g r th ... is as l ... form ... th *E morinellus* ... ac f w th ... w l rs ... h l th ... les larg nd ha m re strongly co t ast l colou th the mal s.

brown — e tige prob bly of f rmer t t of the pl mag Freq tly m tl me g o p f h rd e en with n tl m ge s f 1 1 t

b t m tu Callau tl y g d ff r so m l f m tl p nts th t th y f m ly d sc b d d t t pec

I may mark b f proceed g tl t u d r h t d ext t las e f ases tl

nr g se f m l d th y g lt is, l poss bl th t th m les y l lected th m ttra t

d bl process f select ld b l k ly t occur g t th gr t g ss of se th th th d beth t uld b m re ffi t th select d l It ther f th most prob bl w th t se al select h ted th p ese t class, as f as m t l ch ra t co ce ed accord ce th th g al ul thro gh t the um l k gd m th t is, th m les d that these ha t m tted th grad ually cquired col ur th equally lm t equally t th ff p g f both se

A th po t is m d btful, m ly h th

th cces. at ns first ppeared th m les aft th q t h

n l f tn poss n cases th har ters th us cq red l bee t ns mitted t b th se es d ll ges. B t these char act if quired by th m les h d lt m y ha bee tr nsm tted t first t th d lts l e, d t som bseq t p riod t n f rred t th y g F t k that, h th law of n h rita t corre p d g ges f ls, tl ff pri g oft h t cha act rs t h g tha that t h h th y fir t ppe red th p re ts.[30] Cas pp re tly of this k d ha bee bserv d w th b rd t t f ture F t ice M Blyth h see pec m is f La f d f C l m gl ndus hich h d as umed b l t y g

t y ase f three g rous y g b rds, t f brood of

It m y b rtl h l t llust t tl b thr modes by h h, th p es t lass, th t se l th y g m y ha com t resembl

Jerd B d f Ind l. pp 222, 228 Gould H ndbook to the B ds f A st alia, l. pp 124 130

Could, ibid., l. pp 37 46 6

A d b Ornith B og phy l. ii., p. 55

I ri tio f A mals nd Pl nts nder D m st ation, l. p 79

Cha lesworth M gazine f N t al History

(Cygn lor)

I am ind bted to M Blyth f f rm ti regard t this g us. Th sp rr w f l alestu be l gs t th b-g us P tr nia.

between the sexes is incomparably less than that which frequently occurs in the last class so that the cause of the difference whatever it may have been has here acted on the females either less energetically or less persistently than on the males in the last class Mr Wallace believes that the males have had their colours rendered less conspicuous for the sake of protection during the period of incubation but the difference between the sexes in hardly any of the foregoing cases appears sufficiently great for this view to be safely accepted In some of the cases the brighter tints of the female are almost confined to the lower surface and the males if thus coloured would not have been exposed to danger whilst sitting on the eggs It should also be borne in mind that the males are not only in a slight degree less conspicuously coloured than the females but are smaller and weaker They have moreover not only acquired the maternal instinct of incubation but are less pugnacious and vociferous than the females and in one instance have simpler vocal organs Thus an almost complete transposition of the instincts habits disposition colour size and of some points of structure has been effected between the two sexes

Now if we might assume that the males in the present class have lost some of that ardour which is usual to their sex so that they no longer search eagerly for the females or if we might assume that the females have become much more numerous than the males—and in the case of one Indian Turnix the females are said to be much more commonly met with than the males* —then it is not improbable that the females would have been led to court the males instead of being courted by them This indeed is the case to a certain extent with some birds as we have seen with the peahen wild turkey and certain kinds of grouse Taking as our guide the habits of most male birds, the greater size and strength as well as the extraordinary pugnacity of the females of the Turnix and emu must mean that they endeavour to drive away rival females in order to gain possession of the male and on this view all the facts become clear for the males would probably be most charmed or excited by the females which were the most attractive to them by their bright colour other ornaments or vocal powers. Sexual selection would then do its work steadily adding to the attractions of the females the males and the young being left not at all, or but little modified

*Jerdon *Birds of India*, vol. iii, p 598.

Class III *When the adult male resembles the adult female the young of both sexes have a peculiar first plumage of their own*—In this class the sexes when adult resemble each other and differ from the yo[illegible] occur with [illegible] le n l in can [illegible] emale but [illegible] their mot [illegible] The ma e [illegible] n ue of the splendid scarlet ibis are alike whilst the young are brown and the scarlet colour though common to both sexes is apparently a sexual character for it is not well developed in either sex under confinement and a loss of colour often occurs with brilliant males when they are confined With many species of herons the young differ greatly from the adults and the summer plumage of the latter though common to both sexes, clearly has a nuptial character Young swans are slate-coloured whilst the mature birds are pure white but it would be superfluous to give additional instances These differences between the young and the old apparently depend as in the last two classes on the young having retained a former or ancient state of plumage whilst the old of both sexes have acquired a new one When the adults are bright coloured we may conclude from the remarks just made in relation to the scarlet ibis and to many herons and from the analogy of the species in the first class that such colours have been acquired through sexual selection by the nearly mature males but that differently from what occurs in the first two classes the transmission though limited to the same age has not been limited to the same sex Consequently the sexes when mature resemble each other and differ from the young

Class IV *When the adult* [illegible]

[illegible] adults of both sexes [illegible] brilliant [illegible] obscurely coloured resemble each other [illegible] case are I think more common than [illegible] the last class We have in England instances in the kingfisher some woodpeckers the jay magpie crow and many small dull-coloured birds such as the hedge warbler or kitty wren But the similarity in plumage between the young and the old is never complete and graduates away into dissimilarity [illegible] the young of some members of the kingfisher family are not only less vividly coloured than the adults, but many of the feathers on the lower surface are edged with

paradise) ... fishes conti ue ncreasi g size, as lo g as th y are in good health d ha pl ty of food d somehat similar law may pre ail w th th plumes of birds.

CLASS V. *When the adults f both ex h distinct winter nd summer pl m g whether or not the ... d ffer f om the female ... the adults of both se ... their winter d ... or ... their sum er d ss or they semble the female alone Or the you g m y have ... the adults ... both their seasonal pl m g* —The cases in this class are s ... ularly comple ... thus urprising, as they depend ... nherita ce lim ted in greater or less d gree three diff re t ways, nam ly by sex ge d th seaso of th y ar I som cases th indi duals of th sam pecies pass thro gh t least fi d t ct states of plum g W th th species, hich th mal diff rs from th f male during the summ seaso lo ... hi h is rarer dur g both seasons, th y g g rally resembl th females,—as th th so-called g ldfinch of North America, and pparently with th pl ndid Malurι of Australia. W th these pecies, th se es of hich are alik dur g both th ummer and w n- ... case ... arly t t of pl umag are coloured ... adults dur g th ummer d th y ung of th hite-crowned parrow of North Amer ca (*Fri gill leucophry*), as soo as fledged, ha l ga t whit tripe th ir h ads, h ch are lost by the y g nd th ld dur g th ter. W th respect t th th rd m ly th t of th y g ha g ... dia,—th y g alo be g hit

I ll mak nly f w rema k ... these complicated cases. Wh th y g rese ble th f m les th ir umm dress, r th ad lts f both se es th ir wi t dress, th ca diff from those gi nd Classes I nd III ... th charact rs iginally acq ired by th males dur g th breed ing seaso , ha g bee lim ted th transmission to th corresponding se son. Wh th adult ha dist ct ummer d t plumag nd th y g diff from both, th case is m re d ff cult t d tand. W may dmit as probabl that th y ung h ret ed ... t tat f pl m ge ca account by se ual sel tio for th ummer p- ... b t th re seem good reaso f this admissio It m y be suggested th t th id ly diff re t co d tions of lif during th ter and umm ha ted in direct ma er th plum ge this m y ha had som ffect, b t I ha t much co fid ce so gre t diff re ce as som times see betwee th tw plumages, ha ing bee thus caused A m re probabl planatio is, th t ... t style of plum ge partially modif ed thro gh the transf rence of som charact rs from th ummer ... tra missio ccording t ge, season, d se b t t w uld not be rth hil to mpt t f ll w t thes comple relati ns.

Jerdo *B rds of Ind a,* l. iii., p. 507 ... the peacock. D Marshall thi ks that th lder d more b llia t males of birds of parad se ha

Is see Aud bo *Orn thological Biogr phy* vol. i., p. 172. For the Malurι, Gould *H ndbook of th Birds f Australia*, vol. i., p. 318.

I am d bted t M Blyth f f rmati as t th B phus see also Jerd n, *B ds f Ind* l. p 749 O th Anast mus, see Blyth, *Ibis* 1867

th y ung of certa h rons d grets being hite. *History f British B ds,* l. i., 1839 p. 159.

may have varied when adult and transmitted his plumage to both adult sexes, and owing to the failure of the law of inheritance at corresponding ages, at some subsequent period to his young.

It is impossible to decide which of the three modes has generally prevailed throughout the present class of ca... That the males varied while young and transmitted their variations to their offspring of both sexes, is the most probable. I may here add that I have ... ured ... tl ... ed ... h ... T ...

... which occur ... are transmitted to both sexes) apparently hold good in the first, second and fourth ... of ca... but they fail ...

... generally Dr W. Marshall with respect to the protuberances on the head of birds. Whether ... the two rules generally hold ... we conclude ... that the ...

... moulting of birds, ... within the same family sometimes differs much without any assignable ... Some birds moult so early that nearly all the body feathers are cast off before the first wing feathers are fully grown ... we cannot believe that this was the primordial state of things. When the period of moulting has been accelerated, the ... plumage are ... to be ... by the practice ... by some bird fanciers of pulling out a few feathers from the breast of nestling bullfinches, and from the head or neck of young gold pheasants, in order to ascertain their sex ... in the males, these feathers are ... immediately replaced by coloured ones.[34] The actual duration of life is known in but few birds, so that we can hardly judge by this standard. And with reference to the period at which the power of reproduction is gained, it is a remarkable fact that various birds occasionally breed whilst retaining their immature plumage.

The fact of birds breeding in their immature plumage seems opposed to the belief that sexual selection has played so important a part as I believe it has, in giving ornamental colours, plumes, &c. to the males, and by means of equal transmission, to the females of many species. The objection would be a valid one, if the younger and less ornamental males were as successful in winning females and propagating their kind, as the older and more beautiful males. But we have no reason to suppose that this is the case. Audubon speaks of the breeding of the immature males of *Ibis tantalus* as a rare event, as does Mr. Swinhoe in regard to the immature males of *Oriolus*. If the ... species ... successful ... adult plumage ... preserved ... retained their immature dress for the longest period ... and thus the ... character of the species would ultimately be modified. If ... other ...

For instance, the males of *Tanagra aestiva* and *Fringilla cyanea* require three years, the male of *Fringilla ciris* four years, to complete their beautiful plumage (see Audubon, *Ornithological Biography*, vol. I, pp. 233, 280, 378). The Harlequin duck takes three years (*ibid.* vol. III, p. 614). The male of the gold pheasant, as I hear from Mr J. Jenner Weir ...

... go several years, and the ... *Grus* ... *Ardea ludoviciana* two years, before they acquire their perfect plumage. See Audubon, *ibid.* vol. I, p. 221; vol. III, pp. 133, 139, 211.

[34] Mr. Blyth ... *Ch...* ... p. 203). The *Ibis tantalus* takes four years to attain full maturity, but sometimes breeds in the second year (*ibid.* vol. III, p. 133). The ... takes the same time, but breeds before acquiring its full plumage (*ibid.* p. 211). The adult ... are blue ... and the young white.

... (*ibid.* vol. III, p. 614). The ... Harlequin duck (*Fuligula ... Ornithological Biography*, vol. ... p. 210) ... breed ... Mr Swinhoe, ... of *Oriolus*, according to Mr Blyth and Mr Swinhoe, *Ibis*, July 1863, p. 68, likewise breed before they attain their full plumage. See the last ...

... that the young males of ... the ... several ... breed ... Muller ... (*Ent. Monthly Magazine*, ... 1869, p. 9) the ... males of several ... become sexually mature ... because they ... acquired their fully developed claspers. All such facts are highly interesting, as ... by which species may undergo great modifications of character.

sp
u which occurred ... ...
ag t being th n selected—on th cont ary being oft luminated as dangerou —whilst similar an tio occ rring t or n ar th period f reprod ti ha e been preser ed t f llo s that the plum g f th y g w ll ft has been l ft unmod fied o b t littl modified. We th s get som ns ght to th col uring f th prog nit s f o xi ting peci s. I ast n mbe f pec e in f t f six lasse f as s, tl e ad lts f n sex o f both are bright col ed t l ast d ring th breeding easo wl l t th yo g are anabl l ss brightly col red than th ad lts, are q t d ll col red f r no instance s kn as far as I can disco r f th u g f d ll-coloured peci displaying bright col s, o f th y ung f bright-col ured peci b g m brilliant than th pare ts. In the f urth class, h we in which th yo ng and th ld resembl ach th r th e ar many peci (th gh by n m an all) f which the y ung are b ght-col u ed and as th f m ld gro ps, w m y l th t th arl pro-g nit rs re lik ose bright. W th this excep-ti n, if look to th b rd f the w ld t p-pear that th ir be uty has b n m ch in creased ce that period f which th im mature pl m g gi e u a part al ecord

the e are many black and black-and wl te kinds—all tl e peci s be ng apparently posed to ne ly tl e sam dang rs. It s th re f re prob ble tl t with tree-haunti g b rds, t o gl pron nced colo r l e bee c q red tl rough sexual select n but th t a green t t has been acq red oftener tl n a y otl r from tl e add ti n l advantag of pro-tect

In regard to b rds which l o the grou d e rs one adm ts th t they are colo red so as t m tate tl rrou d g s face H w diffi c lt it is t see a p rtr dge s pe woodcock, certain p lo r larks, a d night jars wl n cro ched n grou d A m ls nhab t g des-e ts ff r th m t t king cases, f r th bare surface aff rd no co cealm nt and n arly all th mall quadrupeds, reptil s, and birds de-pe d f saf ty o tl r colo rs. M Tristram has remarked i regard t the inh b tants f th Sahara, that all re protected by th r isab ll n r sand-col u [30] Call ng t my ecollect n th d sert bird of So th Am ca, as w ll as most f the gro nd-b rd of Gre t

O the Colo f the Pl m g lat on to P otection.—It will ha been seen th t I can t f ll w Mr Wallace th b l f that dull lours, wh n co fined t th f m l h e bee most cases pecially gained f th sak f protecti Th re can, h w b d bt, as f rmerly remarked that both sex of man b rd h had th col urs mod fied so as t scape th n t f th mi r in som instance so as to pproach th p y un bserved j t as wls h had th ir pl m ag rend red soft th t th flight m t b h ard M Wallace marks[31] th t t nly th trop s, am g f re ts wh ch n lose the f li g th t w find wh l g p f b rds, wh se chi f col is gre n. It will be admitted by ry wh has t ed h w d fficult t is t d tingu h pa ts l af-co ed tree N th l ss w m t m mbe th t many parrots are rnam nted with crimson, bl and ang ti ts, which can hardly be prot cti Woodpeck rs ar emin tly arboreal, b t besid green peci s,

... ...
th se b rds t d ff from that of tl ei co g n rs. B tl se f thirteen t of th tw ty si spec are col red n the same mann r b t th se bel g to g n ra in wh l tl rule comm nly p ls, so th t th y t ll noth ing bo t th protect col rs b g the same n b th se f dese t birds. Of tl th r th teen pecies tl ee b l g t g n n whicl th se u ally diffe from ach th r y t h re tl y h th se alik In the remain ing t pec s, th male diff rs from tl e fe-mal b t the d ff re ce confined ch fl to th und urface f th pl m g wh h co ce led wh n th b rd cro ch th g o nd the h d and back b ing f th sam sa d col ed h in th tw se s. So th t n th se t n peci th ppe su face f b th se s ha been cted and rend red like thro gh n t al selecti n, fo the sak f protect n whilst th l w r s rface f the mal l ne

[31] *Westm nster Review* July 1867 p. 5.

[30] *Ibis* 1859 l p. 429 t q D Rohlfs, h w ever remarks t m ta l tt th t ccordi g t his xperi ce of th Sahara, this tatem t is too tro g

CLASS VI *The young in their first plumage differ from each other according to ex the young males resembli g more or less closely the adult males and the yo g femal s mo e or l ss clos ly the adult fem les* — The ca s in the present cl ss, though occurring in various gr ups, are not numerous yet it seems the most natural thing that th young sh uld at first somewhat resemble the n l and The ck rown and I rmed by Mr Blyth that the y ung of both sexes c n be d sti guished by th s char cter ev n as ne thing I the family f tl ru he n unusu l num ber f similar cases have been n ticed thus, the male blackb rd (*Turdus meri la*) can b disti gui hed in the ne t from the female The t o ex s of the mocking bird (*Turdu polyglott s* Linn) d ffer v ry l ttle from each oth r yet the males can ly be distinguished at a very early age from th f n al s by sh ng m r pure whit [46] Th males of a f rest thrush and of a rock thrush (*O oc l s erythrog t a* and *P trocin la yan a*) h e e g w th blu whilst th e f the fem le re edged with brown [47] In the you g black b rd the wi g feathers assum th r mature ch r acte and become bl ck aft r the oth rs on the othe ha d th two pec es just named th wi g feathers beco e blu b f re the others Th most probable view with efer nce to th cases in the prese t cl ss is that the mal s, diff r ntly from what occurs Cla s I h ve tran mitted the r col urs to their male ff p ng at an e h ge than th t at which th y w re fi st cqu red fo f th m l s h d v ried wh lst qu te y ung th ir characters would probably ha been tr nsmitted to b th e es [4]

In *l thu u polytmu* a humm ng b rd th m l is plend dly coloured bl ck and gree nd tw f th ta l f athers re imm ns ly le gth ed the f male has an rdi ry ta l and con p cu us col ur n w tl e y ung mal s, n te d f resembling th adult fem l n accordance w th the common rul b gin from th first t assume the colours prope to th ir sex nd th r ta l-fe th rs soon becom l ng ted I owe thi informati n t Mr Gould wh has gi en me the f llowing more striking and as yet unpublished case Two hun m ging to the ol ured, in- , and have inct. But it y been ascertained th t the one hich is of a rich ch stnut brown colour with a golden-red h ad, the ale h lst the ther hich el gantly variegated ith green and whit with a metallic green h ad is the f m le Now the you g from the first somew hat rese nble the dults of the corresponding sex the re embl nce gradually becom ng m re and m re complete

In con d ring this last case if as before e take the plum ge f the young as our guid it would p- pe r that b th se es have been rend red beautiful ind p ndently nd not that one sex has partially tr sferred its b auty to the other The m le appar ently has cqu red his bright colours thro gh sexual select n in tl e sam manner as, f r instance the pe cock r pheas nt in ur first class of cases nd th fem l th san e mann as the female Rhyn chæa or Tur ix i ur econd lass f as s But there much d fficulty n und rsta d ng how this could hav been effected at th sam t me w th th two s xe of th same species. Mr Salv n st t s, as we hav een in the ghth chapter th t with certain humm ng bird tl e male greatly xceed th females in numb wl l t w tl othe pecies inhab ting th sam cou ntry th fem l greatly exceed th males. If the m ght ss m th t during some f r r l g the ed p riod tl of th Ju n F rna d s peci ha l greatly ceeded th fem l in n mber but th t during an th r l ngthe ed period the fe mal s had f r e ceeded th mal s, we could understand h w th m les at on tim nd th f males at an th n ght ha e been rend red bea t ful l th s l ct f in tru e planation I will n t pre te d to say but the case too remarkabl to be passed o r w th ut n t ce.

We have now een in all six classes that an intimate relation exists b tw ... r cip le that one sex—this being in the great majority of cases tl e male—first ac quired through variation an l sexual selection bright colours or other ornaments, and transmitted them in various ways, in accordance with the recognised la of inl eritance Why variation has occurre l at l ff rent peri ls of life even sometimes witl pecie f tl e same group we do n t know but with re pect to tl e form of transmission one important determin ing cause seems to be the age at which tl e vari ations first appear

Audubon *O nith Biography* v L p 113
[47] Mr C A Wright n *Ibis* vol 1864 p 65 J rd n *L ds f Ind a* I p 515 See also o the blackbird Blyth *Cha l sworth M gaz f N t al H tory* 1837 p 113
[4] The f ll ng dd t al cases m y be m ti ed th y ung l f *T g br* n be dis ti guished fro n the s (Audubon d so t is *D nl phila* *d a* l p ir Blyth Lo inf rms m th t th se f th st nechat, *Saxicola bicola* re dist guish bl t a very early ge. M Sal n e (*I oc Zoolog Soc* 18 0 p 206) the case f a humming bird, lik the follo ng one of Eustepha us.

ed with plumes so long as to impede their flight.

In the same manner as the males alone of various species are black, the females being dull-coloured, so in a few cases the males alone are either wholly or partially white, as with the several bell-birds of South America (Chasmorhynchus), the Antarctic goose (Bernicla antarctica), the silver pheasant, &c., whilst the females are brown or obscurely mottled. Therefore, on the same principle as before, it is probable that both sexes of many birds, such as white cockatoos, several egrets with their beautiful plumes, certain ibises, gulls, terns, &c., have acquired their more or less completely white plumage through sexual selection. In some of these cases the plumage becomes white only at maturity. This is the case with certain gannets, tropic-birds, &c., and with the snow goose (*Anser hyperboreus*). As the latter breeds on the "barren grounds," which are not covered with snow, and as it migrates southward during the winter, there is no reason to suppose that its snow-white adult plumage serves as a protection. In the *Anastomus oscitans* we have still better evidence that the white plumage is of a nuptial character, for it is developed only during the summer; the young in their immature state, and the adults in their winter dress, being grey and black. With many kinds of gulls (Larus), the head and neck become pure white during the summer, being grey or mottled during the winter and in the young state. On the other hand, with the smaller gulls, or sea-mews (Gavia), and with some terns (Sterna), exactly the reverse occurs; for the heads of the young birds during the first year, and of the adults during the winter, are either pure white or much paler coloured than during the breeding-season. These latter cases offer another instance of the *capricious* manner in which sexual selection appears often to have acted.

That aquatic birds have acquired a white plumage so much oftener than terrestrial birds, probably depends on their large size and strong powers of flight, so that they can easily defend themselves or escape from birds of prey, to which moreover they are not much exposed. Consequently sexual selection has not here been interfered with or guided for the sake of protection. No doubt with the birds which roam over the open ocean, the male and females could find each other much more easily when made conspicuous either by being perfectly white or intensely black; so that these colours may possibly serve the same end as the call-notes of many land-birds.[44] A white or black bird when it discovers and flies down to a carcase floating on the sea or cast up on the beach will be seen from a great distance, and will guide other birds of the same and other species, to the prey; but as this would be a disadvantage to the first finders, the individuals which were the whitest or blackest would not thus procure more food than the less strongly coloured individuals. Hence conspicuous colours cannot have been gradually acquired for this purpose through natural selection.

As sexual selection depends on so fluctuating an element as taste, we can understand how it is that, within the same group of birds having nearly the same habits, there should exist white or nearly white, as well as black, or nearly black species,—for instance, both white and black cockatoos, storks, ibises, swans, terns, and petrels. Piebald birds likewise sometimes occur in the same groups together with black and white species; for instance, the black-necked swan, certain terns, and the common magpie. That a strong contrast in colour is agreeable to birds, we may conclude by looking through any large collection, for the sexes often differ from each other in the male having the pale parts of a purer white, and the variously coloured dark parts of still darker tints than the female.

It would even appear that mere novelty, or slight changes for the sake of change, have sometimes acted on female birds as a charm, like changes of fashion with us. Thus the males of some parrots can hardly be said to be more beautiful than the females, at least according to our taste, but they differ in such points, as in having a rose-coloured collar instead of "a bright emeraldine narrow green collar"; or in the male having a black collar instead of "a yellow demi-collar in front," with a pale roseate instead of a plum-blue head.[45] As so many

[43] On Larus, Gavia, and Sterna, see Macgillivray, *History of British Birds*, vol. v. pp. 515, 584, 626. On the *Anser hyperboreus*, Audubon, *Ornithological Biography*, vol. iv. p. 562. On the Anastomus, Mr. Blyth, in *Ibis*, 1867, p. 173.

[44] It may be noticed that with vultures, which roam far and wide high in the air like marine birds over the ocean, three or four species are almost wholly or largely white, and that many others are black. So that here again conspicuous colours may possibly aid the sexes in finding each other during the breeding-season.

[45] See Jerdon on the genus Palæornis, *Birds of India*, vol. i. pp. 258-260.

have been diversified through sexual selection for the sake of ornament Here as both sexes are equally well prot

o that we must look to the law of sexually limited transmission

In all parts of the world both sexes of many soft billed birds especially those which frequent reeds or sedges are obscurely coloured No doubt if their colours had been brilliant they would have been much more conspicuous to their enemies but whether their dull tints have been specially gained for the sake of protection seems as far as I can judge rather doubtful It is still more doubtful whether such dull tints can have been gained for the sake of ornament We must however bear in mind that male birds though dull coloured often differ much from their females (as with the common sparrow) and this leads to the belief that such colours have been gained through sexual selection from being attractive Many of the soft billed birds are songster and a discussion in a former chapter should not be forgotten in which it was shewn that the best songsters are rarely ornamented with bright tints It would appear that female birds as a general rule have selected their mates either for their sweet voices or gay colours but not for both charms combined Some species which are manifestly ol of

our standard of taste with extreme elegance In such cases we may conclude that both natural and sexual selection have acted conjointly for protection and ornament Whether any bird exists which does not possess some special attraction by which to charm the opposite sex may be doubted When both sexes are so obscurely coloured that it would be rash to assume the agency of sexual selection and when no direct evidence can be advanced shewing that such colours serve as a protection it is best to own complete ignorance of the cause or which comes to nearly the same thing to attribute the result to the direct action of the conditions of l f

... ncuon h ... ich a the ... pecies ar l

... en in one of the birds of paradise (*Lophorina atra*) the m

... been a sexually selected character Therefore it is in some degree probable that the complete or partial blackness of both sexes in such birds as crows certain cockatoos, storks and swans and many marine birds, is likewise the result of sexual selection accompanied by equal transmission to both sexes for blackness can hardly serve in any case as a protection With several birds, in which the male alone is black and in others in which both sexes are black the beak or skin about the head is brightly coloured and the contrast thus afforded adds much to their beauty we see this in the bright yellow beak of the male blackbird in the crimson skin over the eyes of the blackcock and capercailzie in the brightly and variously coloured

s leads me to remark that it is not incredible that toucans may owe the enormous size of their beaks to sexual selection for the sake of displaying the diversified and vivid stripes of colour with which these organs are ornamented [51] The naked skin also at the base of the beak and round the eyes is likewise often brilliantly coloured and Mr Gould in speaking of one species [52] says that the colours of the beak are doubtless in the finest and most brilliant state during the time of pairing There is no greater improbability that toucans should be encumbered with immense beaks though rendered as light as possible by their cancellated structure for the display of fine colours (an object falsely appearing to us unimportant) than that the male Argus pheasant and some other birds should be encumber

[51] ... satisfactory ... pl ... t ... has ... been offered ... of the ... se ... nd ... of the bright colours, ... Mr B ... t (*The Nat al ... the* ... 1863 p 341) ... th ... they use the ... beaks ... fruit ... But Mr B ... sc rcely ... pe fectly ... bulk of the beak ... breadth ... that ... Mr B ... (*The Nat al ... Nat* ... p 197) that th ... pal ... of th ... tree

[52] *Rhamphastos carinatus* Gould *Monograph of Ramphastidae*

same g ral style f ornamentati n o ther attractions, and yet appreciating l ght changes in colours, form o sound

S mmary f the F Chapt s i Birds — Most m le birds are highly pugnaci s during th breed se son and some possess w pons

o r to charm th f mal s b l ve-d ces or antics, perfo med n th grou d n th

by far tl comm t m ns I som cases m re lt ppears t l ted as a charm Tl rn m t f tl m l m t be highly mpo tant t th m f tl l been acq ired in t f ase t tl cost f in creased dang from and t som loss f po in fi hting w th th ri ls. Th mal s f rs many pec do t as me the rnam tal dress t l tl ri e t m turit th ssum t l d g th breed ing season. th t t tl becom n re tvid Certai rnamental ppend ge becom nlarged t gid d brightly col red d ri g th act f co rtsh p Th m l d play tl ir harms w th labo t re and t th be t ffect and thi is d th pre ce f th f males Th co tship som t pro lo ged affai ai d man m l d f males

decorations, all th pomp an l d pl y are useless and this red bl B rds ha fin po rs f disc min tio and some f w tances t an b h wn that tl h tast f th be ti l Th f males, m reo are know occas nall to xh b t ma ked pre f re ce antipathy f ce tain ind d al males

If t be adm tted that the f males prefer o are unconsc ously excited by the more beauti ful mal s, then the males would slowly l ut rely be rend red m re and more attracti e thro gh se u l selecti n That it is tl sex h cl l as been chi fly modified we may infer from th fa t that n almost every g n s wl ere tl e sp es d ff r the males d ff r n l n re fro n on an th r than do th f mal s thus is ll sl ewn in certain closely-all ed wh l tl e f males

ffice f tl wo k of sexual select on t

ind t the n t re f the t ps thro gl wl t th ha e passed Th y xplain also tl most tere tu g mann r h w certain charac t rs h rigi ated ch as the nd ted ocell n tl e tail f th rs of th peacock, l th ball-and sock t ocell on the wing f th rs f tl Argu pl asant It e id t that tl brill t colo rs, t p-knots, fin pl m s, &c f many n al b rd nn t ha been equ red as a protect ndeed th y somet mes l d to lan That th y are not d e to the d rect and d finite act n f the co d t ns f life we may feel assured bec se tl femal s ha bee posed t tl sam co dit ns and y t ft n diff from th males t n trem de gree Alth gh t is probabl that changed co d t ons t ng duri g a l ngth ed per od ha some a produced d finite ffect both se s, o som tim n e sex al e, th m re mpo tant re lt will ha been an reased t d y t ary t present m re tro gly ma k d d id l d ff re ce and ch difference will ha e aff rded an xcel l t ground w k f the action f sexual select

Th l s f nh ritance, irrespecti ely of select n ppe t ha dete mined wh tl th char t rs q red by th mal f the sak f rn m t f prod cing an u so d an l f fight g t th ha e been t m t t d t th mal al or to both sex s, ther pe ma tly period ally d ri g ce t n aso f tl year Why ari cl r t should ha been tr nsmitted som tim s in

iers or elon

the short-

formerly described in the male of a humming bird and the shortened crest of the male goosander seem like one of the many changes of fashion which we admire in our own dresses

Some members of the heron family offer a still more curious case of novelty in colouring having as it appears been appreciated for the sake of novelty Tl e sha ed eir

of the allied *Buphus coromandus* are white this colour changing into a rich golden buff during the breeding season It is incredible that the young of these two species as well as of some other members of the same family [14] should for any special purpose have been rendered pure white and thus made conspicuous to their enemies or that the adults of one of these two species should have been specially rendered white during the winter in a country which is never covered with snow On the other hand we have good reason to believe that whiteness has been gained by many birds as a sexual ornament We may therefore conclude that some early progenitor of the *Ardea asha* and the Buphus acquired a white plumage for nuptial purposes and transmitted this colour to their young so that the young and the old became white like certain existing egrets and that the whiteness was afterwards retained by the young whilst it was exchanged by the adults for more strongly pronounced tints But if we could look still further back to the still earlier progenitors of these two species we should probably see the adults dark coloured I infer that this would be the case from the analogy of many other birds which are dark whilst young and when adult are white and more especially from the case of the *Ardea gularis* the colours of which are the reverse of those of *A asha* for the young are dark-coloured and the adults white the young having retained a former state of plumage It appears therefore that during a long line of descent the adult progenitors of the *Ardea asha* the Buphus and of some allies have undergone the following changes of colour first a dark hale secondly pure white and thirdly owing to another change of fashion (if I may so express myself) their present slaty reddish or golden buff tints These successive changes are intelligible only on the principle of novelty having been admired by birds for its own sake

Several writers have objected to the whole theory of sexual selection by assuming that with animals and savages the taste of the female for certain colours or other ornaments would not remain constant for many generations that first one colour and then another would be admired and consequently that no permanent effect could be produced We may admit that taste is fluct

ated Abundant evidence will be given in two places in a future chapter that savages of many races have admired for many generations the same cicatrices on the skin the same hideously perforated lips, nostrils, or ears distorted heads, &c and the cicatrices present some analogy to the natural ornaments of various animals. Nevertheless, with savages such fashions do not endure for ever as we may infer from the differences in this respect between allied tribes on the same continent So again the rai ers of fancy animals certainly have admired for many generations and still admire the same breeds they earnestly desire slight changes, which are considered as improvements but any great or sudden change is looked at as the greatest blemish With birds in a state of nat

the case We know that dovecot pigeons do not willingly associate with the variously coloured fancy breeds that albino birds do not commonly get partners in marriage and that the black ravens of the Feroe Islands chase away their piebald brethren But this dislike of a sudden change would not preclude their appreciating slight changes, any more than it does in the case of man Hence with respect to taste which depends on many elements but partly on habit and partly on a love of novelty there seems no improbability in animals admiring for a very long period the

[14] The young of *Ardea rufescens* and *A caerulea* of the United States are likewise white the adults being coloured in accordance with their specific names. Audubon (*Ornithological Biography*, vol. iv. p. 416 ... p. 58) seems rather pleased at the thought that this remarkable change of plumage will greatly disconcert the systematists."

sn. ace in tl males alo e has been n u ly ornamer ted thro gh sexual select n. I nally from tl facts gi in tl ese f u ch pt rs, we may concl d th t weapons f b ttle organs for producing sound am ts f many kinds, bri ht and con p cu us colours, h g nerally bee acquired by th mal thro gh ariatio and sexual select n, and h e been transmitted in ari us w ccordin to th several law of inh ritance—th females and tl e y g being left comparati ly but little mod fied.[57]

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ything as fact which an guished naturalist to be erroneous. But of course he is ot t all nswerable f th accuracy of th tatements quoted by m from various thorities.

one way and sometimes in another is not in most cases known but the period of variability seems often to have been the determining cau e When the two exe have inherited all *characters in common they r cee sarily re em ble each other* but as the uccessive varia tions may be differently tran mitted every possible gra lation may be foun l even within the same genus from the closest imilarity to the widest dissimilarity between the sexes With many closely allied pecies following nearly the same habits of life the males have come to differ from each other chiefly through the action of sexual selection whilst the fe males have come to differ chiefly from partak ing more or less of the characters thus acquired by the males The effects moreover of the definite action of the conditions of life will not have been masked in the females as in the males, by the accumulation through sexual se *lection of trongly pronounced colours and* other ornaments The in lividuals of both sexes however affected will have been kept at each successive period nearly uniform by the free intercrossing of many individuals

With specie in which the sexes differ in col our it is possible or probable that some of the succes ive variations often ten led to be trans- mitted e jually to both sexes but that when this occurred the females were prevented from acquiring tl e bright colours of the males by the le truction which they suffered during in cubati on There is no evidence that it is possi ble by natural sel ction to convert one form of transmis ion into another But there would not be the least difficulty in ren lering a female dull-coloure l the male being still kept bright coloured by the selection of successive varia tions, which were from the first limited in their transmission to the same sex Whether the fe males of n any pecies have actually been thus modified must at present remain loubtful When tl rough the la v of the equal transmis- sion of characters to both sexe the females vere ren lered as conspicuou ly colour l as tl e males, their n tincts appear oft n to l ave been m dified so that they were led to l uil l lon ed or conceal l nests

In one small and curious class of cases the characters an l l abits of tl e tv o sexes l ave been comp letely tran posed for tl e females are larger tronger more vocife ous an l brighter coloured than the male Ih y l a *also* becom so juarrelsome tl at they often fight togetl er for the posses ion of the mal s, like the males of other pugnacious species for the possession of the females. If as seems prob- able such females habitually drive away their rivals, and by the di play of their bright col ours or other charms en le avour to attract the males, we can u ider tan l how it is that they have gra lually been rendered, by sex ual selection and sexually limited transmis sion more beautiful than the males—the latter being left unmodified or only l htly modified

Whenever the law of inheritance at corre- spon ling ages prevails but not that of sexually limited tran mission then if the parents vary late in life—and we know that this constantl occurs with our poultry and occasionally with other birds—the young will be left un affected whilst the adults of both sexes will be modified If both these laws of inheritance pre- vail and either ex varies late in life that sex alone will be modified the other sex an l tl e *young being unaffected When variati n in* brightness or in other con picuous characters occur early in life as no doubt often hap pens they will not be acted on through sexual s lec tion until the period of reproduction arrives

I

tions ari ing late in lif have so often been pre serv l for the ornamentation of the m les the fem iles an l the young being l ft almo t un affected an l therefore like each other With

during the summer alon tl e legrees and kin ls of resemblance l etw en the youn g and the ol l are exceedingly complex ar l tl is com plexity apparently lepen l n characters, first acquired by the males, being tran mitted in various ways and degrees, as limited by age sex an l season

As the young of so many peci have been but little modifi d in colour an l in otl er orna- ments v e are en l led to f rm som ju lgment with re pect to th j lu i g f tl eir early pro- gen it r and we may n f r tl at tl e beauty f our exi ting pecies, if we l ok t tl e wl le class has been largely increased ince that period of which tl e immature p l image gives us an in lirect record M ny l irds, especially those wl ich live much on tl ground l ave un loul tedly l een ol scurely col ure l f r tl e sake of pr tecti n In so e in tances tl e up- per e posel urface f tl e plumage l as been thus coloured in botl sexes, wl ilst the lower

lopes in which the females are hornless. With many animals the canine teeth in the upper or lower jaw, or in both, are much larger in the males than in the females, or are absent in the latter with the exception sometimes of a hidden rudiment. Certain antelopes, the musk deer camel, horse boar various apes, seals, and the walrus, offer instances. In the females of the walrus the tusks are sometimes quite absent. In the male elephant of India and in the male dugong[3] the upper incisors form offensive weapons. In the male narwhal the left canine alone is developed into the well known, spirally-twisted, so-called horn, which is sometimes from nine to ten feet in length. It is believed that the males use these horns for fighting together: for an unbroken one can rarely be got, and occasionally one may be found

[illegible]

[illegible] female both are always rudimentary. The male cachalot has a larger head than that of the female, and it no doubt aids him in his aquatic battles. Lastly the adult male Ornithorhynchus is provided with a remarkable apparatus, namely a spur on the foreleg, closely resembling the poison-fang of a venomous snake but according to Harting, the secretion from the gland is not poisonous and on the leg of the female there is a hollow, apparently for the reception of the spur.

When the males are provided with weapons which in the females are absent, there can be hardly a doubt that these serve for fighting with other males and that they were acquired through sexual selection, and were transmitted to the male sex alone. It is not probable, at least in most cases, that the females have been prevented from acquiring such weapons, on account of their being useless, superfluous, or in some way injurious. On the contrary, as they are often used by the males for various purposes, more especially as a defence against their enemies, it is a surprising fact that they are so poorly developed, or quite absent, in the females of so many animals. With female deer the development during each recurrent season of great branching horns, and with female elephants the development of immense tusks, would be a great waste of vital power, supposing that they were of no use to the females. Consequently they would have tended to be eliminated in the female through natural selection, that is, if the successive variations were limited in their transmission to the female sex, for otherwise the weapons of the males would have been injuriously affected, and this would have been a greater evil. On the whole, and from the consideration of the following facts, it seems probable that when the various weapons differ in the two sexes, this has generally depended on the kind of transmission which has prevailed.

As the reindeer is the one species in the whole family of deer in which the female is furnished with horns, though they are somewhat smaller, thinner and less branched than in the male, it might naturally be thought that, at least in this case, they must be of some special service to her. The female retains her horns from the time when they are fully developed, namely in September, throughout the winter until April or May, when she brings forth her young. Mr Crotch made particular enquiries for me in Norway, and it appears that the females at this season conceal themselves for about a fortnight in order to bring forth their young, and then reappear generally hornless. In Nova Scotia, however, as I hear from Mr H. Reeks, the female sometimes retains her horns longer. The male on the other hand casts his horns much earlier, towards the end of November. As both sexes have the same requirements and follow the same habits of life, and as the male is destitute of horns during the winter, it is improbable that they can be of any special service to the female during this season, which includes the larger part of the time during which she is horned. Nor is it probable that she can have inherited horns from some ancient progenitor of the family of deer, for, from the fact of the females of so many species in all quarters of

M. Lamont ... *Seasons with the Sea-Horses*, 1861, p. 143 ... that ... tusk of the male walrus ... 4 pounds, and is longer than that of the female, which weighs about 3 pounds. The males are described as fighting ferociously. On the occasional absence of the tusks in the female see Mr. R. Brown, *Proc. Zoological Soc.* 1868, p. 429.

[3] Owen, *Anatomy of Vertebrates*, vol. iii. p. 283.

Mr. R. Brown, *Proc. Zool. Soc.* 1869, p. 553. See Prof. Turner in *Journal of Anat. and Phys.* 1 ... p. ... on the homological nature of these tusks. Also Mr. J. W. Clarke on two tusks being developed in the males, in *Proceedings of the Zoological* ..., p. 252.

CHAPTER XVII

SECONDARY SEXUAL CHARACTERS OF MAMMALS

WITH mammals the male appears to win the female much more through the law of battle than through the di play of his charms The most timid animals not provide l with any special weapons for fighting engage in le per ate conflicts luring the sea on of love Two male hares have been seen to fight together until one was killed male moles often fight and sometimes with fatal results male squirrels engage in frequent conte ts an l often wound each other everely as lo male beavers so that har lly a kin is without scar [1] I ob erved the ame fact with the hi les of the guanacoes in Patagonia and on one occa ion several were o al sorbe l in fighting that they fearlessly rushed clo e by me Livingstone speaks of the males of the many animals in outhern Africa as almost invariably hewing the scars received in former contests

The law of battle prevails with aquatic a with terrestrial mammal It is notorious how de perately male eal fight b th with their teeth an l claw luring the breeding s a on an l their hides are likewi e oft n cov red with scars Male sperm whales are very jealous at this season an l in their battles they oft n lock their jaws together and turn on their si les and twist about o that their lower jaws often become di torte l

All male animal which are furni he l with speci il weapon for fighting are w ll known to engage in fierce battle The courage an l the de perate conflicts of stags have often l een de cribed their skeletons have been foun l in va ious parts of the worl l with th horns in extri ably locked together he ving how mi erably the victor an l van ui le l l a l per ishe l No animal in th worl l is o langerous as an elephant in must Lor l Tankerville has given me a graphic le cripti n of the battles between the wil l bull in Chillingl am Park the le cen lants, degenerated in ize but not in courage of the gigantic *Bos pri igeni s* In 1861 everal contend d for ma tery an l it w s ol erve l that two f the y unger l ulls at tacke l in concert the ol l lea ler of the her l overthrew an l h al l l him that he was believe l l y the keeper to l e lying mortally woun le l in a neighl uring wood But a few lay afterwar l one f the young l ulls approach l th w oc l al ne an l th n the mon arch of the cl c wh ha l l een la hing l im self up for vengeance c ime ut an l in a hort time kille l hi antag nist He then quietly joine l the her l an l long l l l un li puted sway Admiral Sir B J Sulivan inf rms me tl at wl en l liv l in the Falkland I lan ls, he imp rt l a y ung English tallion which frequent l the hill n ar P rt William with eight mare On tl e hill th r w r tw wil l tal li n a h ith a m ll tr p f mare and it i certain tl at tl talli n w ul l never have appr ach l each tl er with out fighting Both ha l tr l ingly to fight tl English hor e an l lrive away l is mar s l ut ha l fail l One lay tl ey cam in t g th er an l attack l him Thi a n l y the captain who ha l charge of th hor a l w lo n riding t the p t f un l ne of tl tw o talli ns ngaged with th Engl h h r wl il t the ther wa lriving a ay th m r an l ha l alrea ly sep rated f ur fr m th r t He e ttl e l th matt r l y lriving tl wl ole party into a c ral f r tl il l t lli n woul l n t lea e tl e mare

Male ani al wl i l re r ul l ith th e ent cutting r t ar i g teeth f tl r l u r purpose f t e h tl Carniv r Insect vora n l ro l nt ar sel l m furni l ed th w apon pe ally a lapted fo fighting with their rival The r ry l ff r nt tl tl male of m ny otl ar imal W see tl m th l rn of tag a l l f rtain k n l f ant

[1] See W t rt ceo t f t l res fighting *Zool g t vol i* 1843 p 211 O l s, Bell *Hist f British Q adrupeds* 1 t ed p 100 O squirrels, Aud bon and B hman *Viviparous Q adrupeds f N America*, 1846 p 269 O b rs, M A H Green in *Jou al f L Soc t Z l g* 21 l

l bbett n l d Si ced l p 414 also l t On tl sperm hal see Mr J H Th mps *Proc Zool Soc* 186 p 246 See Scrope (*Art f Deer-stalk g* p 17) on the lock ing f the h rns ith th *Cerv l ph* R h rdson *Fa a B l m ri* 1829 p 252, says that th f se l r lee l ber f u l tl l ocked t gether tl f l l th C pe of G l H pe th k l l f t as th sa co l l n.

in the bull than in the cow and in the cow tauring (*Bos sondaicus*) the horns are remarkably small, and inclined much backwards. In the domestic races of cattle, both of the humped and humpless types, the horns are short and thick in the bull, long and more slender in the cow and ox and in the Indian buffalo, they are shorter and thicker in the bull, longer and more slender in the cow In the wild gaour (*B. gaurus*) the horns are mostly both longer and thicker in the bull than in the cow.[14] Dr Forsyth Major also informs me that a fossil skull, believed to be that of the female *Bos etruscus* has been found in Val d'Arno, which is wholly without horns. In the *Rhinoceros simus* as I may add, the horns of the female are generally longer but less powerful than in the male and in some other species of rhinoceros they are said to be shorter in the female.[15] From these various facts we may infer as probable that horns of all kinds, even when they are equally developed in the two sexes, were primarily acquired by the male in order to conquer other males, and have been transferred more or less completely to the female.

The reindeer however must be excepted, as after castration he does renew them. This fact, as well as the possession of horns by both sexes, seems at first to prove that the horns in this species do not constitute a sexual character but as they are developed at a very early age before the sexes differ in constitution, it is not surprising that they should be unaffected by castration, even if they were aboriginally acquired by the male. With sheep both sexes properly bear horns and I am informed that with Welch sheep the horns of the males are considerably reduced by castration but the degree depends much on the age at which the operation is performed, as is likewise the case with other animals. Merino rams have large horns, whilst the ewes generally speaking are without horns and this breed castration seems to produce some what greater effect, so that if performed at an early age the horns remain almost undeveloped.[16] On the Guinea coast there is a breed in which the females never bear horns, and, as Mr Winwood Reade informs me the rams after castration are quite destitute of them. With cattle the horns of the males are much altered by castration for *instead of being short and thick*, they become longer than those of the cow but otherwise resemble them. The *Antilope bezoartica* offers a somewhat analogous case the males have long straight spiral horns, nearly parallel to each other and directed backwards the females occasionally bear horns, but these when present are of a very different shape for they are not spiral, and spreading widely bend round with the points forwards. Now it is a remarkable fact that, the castrated male as Mr Blyth informs me the horns are of the same peculiar shape as in the female but longer and thicker If we may judge from analogy the female probably shews us, in these two cases of cattle and the antelope, the former condition of the horns in some early progenitor of each species. But why castration should lead to the reappearance of an early condition of the horns cannot be explained with any certainty Nevertheless, it seems probable that in nearly the same manner as the constitutional disturbance in the offspring, caused by a cross between two distinct species or races, often leads to the reappearance of long lost characters[17] so here the disturbance in the constitution of the individual, resulting from castration, produces the same effect.

The tusks of the elephant, in the different species or races, differ according to sex, nearly as do the horns of ruminants. In India and Malacca the males alone are provided with well-developed tusks. The elephant of Ceylon is considered by most naturalists as a distinct race but by some as a distinct species, and here not one in a hundred is found with tusks, the few that possess them being exclusively males.[18] The African elephant is undoubtedly distinct, and the female has large

[14] *Land and Water* 1867 p. 346.

[15] Sir Andrew Smith, *Zoology of S. Africa*, pl. xix. Owen, *Anatomy of Vertebrates*, vol. iii, p. 624.

[16] This is the conclusion of Seidlitz, *Die Darwinsche Theorie* 1871 p. 4

[17] I am much obliged to Prof. Victor Carus, for having made enquiries for me in Saxony on this subject. H. von Nathusius (*Viehzucht* 1872, p. 64) says that the horns of sheep castrated at an early period, either altogether disappear or remain as mere rudiments but I do not know whether he refers to merinos or to ordinary breeds.

I have given various experiments and other evidence proving that this is the case, in my *Variation of Animals and Plants under Domestication*, vol. ii, 1868, pp. 39-47.

[18] Sir J. Emerson Tennent, *Ceylon*, 1859, vol. ii, p. 274. For Malacca, *Journal of Indian Archipelago*, vol. iv, p. 357.

the globe not having horns we may conclude that this was the primor hal character of the group[8]

The horns of the reindeer are developed at a most unusually early age but what the cause of this may be is not known The effect has ap parently been the transference of the horns to both sexes We shoul l bear in mind that horns are always transmitted through the female and that she has a latent capacity for their development as we see in old or hseased fe males[9] Moreover the females of some other species of deer exhibit either normally or oc casionally rudiments of horns thus the fe male of *Cervulus moschatus* has bri tly tufts endin, in a knob instead of a horn an l in most pecimens of the female wapiti (*Ce rus canaden is*) there is a sharp bony protuberance in the place of the horn [10] From these everal considerations we may conclude that the pos session of fairly well develope l horns by the female reindeer is due to the male having first ac juired them as weapons for fighting with other males and secondarily to their de velopment from some unknown cause at an unusually early age in the males and their consequent transference to both sexes

Turning to the sheath horne l ruminants with antelopes a graduated series can be formed beginning with pecies the females of which are completely destitute of horns—passing on to those which have horns so small as to be almost rudimentary (as with the *Antilocapra ame icana* in which pecies they are present in only one out of four or five fe males[11])—to those which have fairly level oped horns but manifestly smaller and thinner than in the male and sometimes of a different shape [12]—and ending with those in which both sexes have horns of equal size As with the reindeer so with antelopes there exists, as previously shewn a relation between the period of the development of the horns and their transmis ion to one or both sexes it is therefore probable that their presence or absence in the females of ome pecies, and their more or less perfect con lition in the females of other pecies depends not on their being of any pecial use but simply on inheritance It accor l with this view that even in the same restricted genus both sexes of some peci s, and the males alone of others, are thus provided It is also a remarkable fact tl at al though the females of *Antilope be.oartica* are normally lestitute of horns Mr Blyth has seen no less than three females thus furm hed and there was no reason to suppose tl at th y were ol l or [13]

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anc.. ometimes juite al sent in the latter [15] In everal dome tic breeds of these two ani mals the males alone are furni hed with horns and in some breeds, for in tance in the sheep of North Wales though both sexes are properly horned the e ves are very hal le to be hornless I have been informed l y a trust worthy witne s who purj osely in pected a flock of the e same sheep luring tl e laml ing season that th horns at birth are ger er lly more fully developed in the male tl an in the female Mr J I eel er s.ed his Lonk heep both exes of which al vays bear l rns, with hornless Leice ters an l horml ss Shrop l ire Downs and the result was that the male off spring had their horns onsi lerat ly reduced whilst the females were v holly lestitute of them The sev ral facts in licate tl at with sheep the l orns are i much le firi ily fixed character in tl e fe nales than in tl e males n l thus l a ls us to look at tl e l orns as properly of masculine orig n

With tl e a lult musk-ox (*Oribos m sel atus*) the l orns of tl mal are larg r than tl ose of the fen al and in the latter tl l ases lo not touch In reg rd to or l i ary cattle Mr Blyth rei iarks In mo t of th wil l bovine animals tl e l orn are both long r an l tl icker

[8] O the tructure n l l edd ng of the l rns l the re nd r H ffb rg *Iman t t l ad.* v l. i l 88 p 149 See R h rdso *F Bor America* p 241 in reg rd to th Am c n ri ty pec lso M j W R ss K g *Tl Spo ts n in Canada* 1866 p 80

[9] I d re Geoffroy St Hila r *E u d Zool g Gl ic al* 1841 p 513 Oth r m scul h ract rs, bes des th l r s, re s n t n la ly trans f rred t tl e f m l tl M n f

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f [illegible]

[10] On th Cervulus D Gray *C ta.og f M m mal a n the British Museum* p rt i 220 O th *Cervu canadensis* or w p ti, see H J D C t n, *Ott w l al y f N t Sci nc* M y 1 64 p 9

[11] I am i d bted to Dr C nf kl l this f rr tio see also his paper n th *I oceed g f the Zoological Society* 1866 p 105.

[12] F nst ce tl l of th f m le *Ant uchore* rese nbl l th se l d t t pec s, i.e. th *Ant. dorcas* rine see D marest, *M mmalogie* p. 455

[13] Gray *C t log f M mmalia, the British Mu s m*, part 1850 p. 160.

[14] Ri hardson, *F na Bor Americana*, p. 2?3.



Fi 63 *O y l ory m l* (from th *Knowsley Men geri*)

af rms m th t wh n tw f th nimals prepare f battle th y kneel dow with th h ads between tl f l gs, and in this atti t d th h rn tan l ly parall l and cl t tl gro d w tl tl points d ected fo w d l l ttl p ard The combatants

th f l g d to b g tl points f th h rns f rw rd h w uld g lly be und gre t disad ant g wh ttacked by any th animal It th ref re n t p b bl

see that, as soo as som anci t mal p g nto f the Oryx acq ired mod t ly lo g h ns, directed l ttl backw rds, h w ld b compelled hı b ttl w th ri al mal s, to be d h h ad som wh t w rd d nwards, as w d by certain tag and t not mp b bl th t h ght h acqu red th hab t f t first occas nally nd aft rward f gularly kneeling d w In thi case t alm t certain tl t th mal which possessed tl l g t h rns w ld ha had gre t ad ant g tl w th sl t horns and tl n th h rns w ld grad lly ha bee re d red l g and lo g thro gh se al select til th y acq red th p s- t traordinary l gth and po ti n.

With st gs f many k nds the branches of t ff n s ase f d ffi ulty f r

thirty ... fiftee ag r b an h and t M ritzbu g th i st ll pr se ed a pair of antlers f a red-dee h t in 1699 by Fred rick I n of wl h b ars th ast nish g numbe f thi ty tl r b an h s and tl e oth twe ty se en maki g alt g the xty b anches Richardson figure pai f antl f th wild reindee w th tw nty nin po ts[24] F m th mann which tl h n b anched and m pecially f m dee b g k wn occas onally to fight t g th by k ki g w th th r f re f t[25] M Baılly t lly m s to the con fu n th t th ir h rns re m e inj ri u than useful to th m B t tl uth c looks th p tched b ttl b tw n ri al males I f lt much perpl ed ab t th us or ad ant ge f th b an h I ppl ed to M Mc N ill f C l say wl has l g and carefully b ed th h b ts f ed-dee and h n f rm m th t l e has n een som of th b an hes b ght int se, b t that the brow antl f m in liming d wnwards, are a g at protection to th f head and th ir po nts ar lik ise sed in ttack S Phil p Eg rt n lso

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Sciences Nat., t m. ii., 1824 p 371

well-developed tusks though not so large as those of the male

These differences in the tusks of the several races and species of elephants—the great variability of the horns of deer as notably in the wild reindeer—the occasional presence of horns in the female *Antilope bezoartica* and their frequent absence in the female of *Antilocapra americana*—the presence of two tusks in some few male narwhals—the complete absence of tusks in some female walruses—are all instances of the extreme variability of secondary sexual characters and of their liability to differ in closely allied forms

Although tusks and horns appear in all cases to have been primarily developed as sexual weapons they oft n pur king the down [illegible] likewise thus extracts the farinaceous cores of palms in Africa he often uses one tusk always the same to probe the groun l an l thus ascertain whether it will bear his weight The common bull defends the herd with his horns and the elk in Sweden has been known according to Lloyd to strike a wolf dead with a single blow of his great horns Many similar facts could be given One of the most curious secondary uses to which the horns of an animal may be occasionally put is that observed by Captain Hutton[21] with the wild goat (*Capra ægagrus*) of the Himalayas and as it is also said with the ibex namely that when the male accidentally falls from a height he bends inwards his head and by alighting on his massive horns breaks the shock The female cannot thus use her horns, which are smaller but from her more quiet disposition she does not need this strange kind of shield so much

Each male animal uses his weapons in his own peculiar fashion The common ram makes a charge and butts with such force with the bases of his horns that I have seen a powerful man knocked over like a child Goats and certain species of sheep for instance the *Ovis cycloceros* of Afghanistan[22] rear on their hind legs and then not only butt but make a cut down and a jerk up with the ribbed front of their scimitar shaped horn as with a sabre

[21] *Calcutta Journal of Nat. Hist.* [illegible] 1843 p 526

[22] Mr Blyth *Land and Water* March 1867 p 134 on the authority of Capt. Hutton [illegible] For the wild Pembrokeshire goats, see the *Field*, 1869 p. 150.

When the *O cycloceros* attacked a large domestic ram who was a noted bruiser he conquered him by the sheer novelty of his mode of fighting always closing at once with his adversary and catching him across the face and nose with a sharp drawing jerk of the head and then bounding out of the way before the blow could be returned In Pembrokeshire a male goat the master of a flock which during several generations had run wild was known to have killed several males in single combat this goat possessed enormous horns measuring thirty nine inches in a straight line from tip to tip. The common bull as every one knows, gores and tosses his opponent but the Italian buffalo is said never to use his horns he gives a tremendous blow with his convex forehead and then tramples on his fallen enemy with his knees—an instinct which the common bull does not possess[23] Hence a dog who pins a buffalo by the nose is immediately crushed We must however ren [illegible]

[illegible] horns Mr Bartlett informs me that when a female Cape buffalo (*Bubalus caffer*) was turned into an enclosure with a bull of the same species she attacked him and he in return pushed her about with great violence But it was manifest to Mr Bartlett that had [illegible]

[illegible] short hair-covered horns, which are rather longer in the male than in the female in a curious manner for with his long neck he swings his head to either side almost upside down with such force [illegible]

[illegible] they can possibly use their curious shaped horns thus the springboc (*Antilope euchore*) has rather short upright horns, with the sharp points bent inwards almost at right angles so as to face each other Mr Bartlett does not know how they are used but suggests that they would inflict a fearful wound down each side of the face of an antagonist The slightly-curved horns of the *Oryx leucoryx* (fig 63) are directed backwards and are of such length that their points reach beyond the middle of the back, over which they extend in almost parallel lines Thus they seem singularly ill fitted for fighting but Mr Bartlett

[23] M E. M Bailly "Sur l'usage des cornes," &c., *Annal des Science Nat.*, tom. [illegible], 1824 p. 369

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thus ad antag th p k h rn b cks are gau ing po th comm b ks, ard m v n tim turel supersede tl m n th Adiron dacks. Lnd bted! th first p k l rn bu k as merely an accid t l fre k f n ture But his spk horns g l im an ad anta a d nabled him t propag t h pecul art H descendant h ving l k ad tag l a propa, ted th peculiar ty n constantl n creasing rat o, till th v are l wly wd g th antl red dee from th gi tl habt. A rit e has w ll bjected t thi ac count by aski g wh if th mpl l rn are no so ad anta eo s, w th l anched antl rs of th pare t f rm er d el ped To this I can nly an w by remark g that a ew mod f ttack with n w w po m ght be gre t ad antag as sh wn by tl ase f th *Ovis cycloceros* wh thus co q ed a domesti ram fam f hi figl t g pow Tho gh th b anched antlers of t g are w ll ad pted f fight g wit! hi ri als, and tl gh t might be an ad antag t th pro g l rned an ty sl ly t acqui l n and bran hed l rns, if h had to fight nl w th tl rs f the sam kind y t t by m ans f llow that brancl ed h rns w ld b th be t fitted f co q ring foe diff re tl armed In th f regoing ase f th *Ory le co y* t alm t

ward tl m k-dee d wnward w th seri us ffec
eck
th
with
lat D F lco that th Ind ar l phant fights diff re t an according t he positi and ri t re f l t ks. Wh tl are directed f rward and pward l abl t fling t g t gre t d tance— t said t thirty feet wh tl v are h rt and t rned d ward h d urs d

d nl to p n tl t g r to tl e grou d and in conseque ce i dang rou to tl e ri l r who is liable t be j ked off tl l wdal [20]

V ry f w n al quadrupeds possess weapons of two d tin t kin d pec ally d pted f r figl ti g w th ri al m le Tl e m l muntjac deer (C rvul) l r offers an xcept as l e i pro ded witl l orns and exserted canine teeth B t we m y nf r f om what f ll that o e f m f we pon ha ft n bee replaced n the course f age by an tl e W th ruminants the de elopm nt of h rns g n rall tand n an ve se rel t n witl that f e en mod t ly de l ped can e teetl Tl u m l gua acoes, cl vrotains, and musk-dee ar l rnless, and th y l v f fi nt can s th se teeth be lways of sm ll ze n tl f males tl an n tl e mal s. Tl Cam lidæ ha e in add t n to tl ir true s. pai f an n haped incisors n thei pper j ws. Male deer and ant l pes, n tl tl l and possess h n and tl rarely l v an ne teetl and these wl n prese t are alwa s f mall size so that it s do btf l wl the tl v ar f any service n th b ttl s. In *A tilope m t a* th ist o ly as rud m nts in th g mal disappear g as l e grow ld and tl ey are al se t n th f mal t all ag but the femal f certain tl ant l pe and of ce ta n dee l been k wn occa. ally t xl b t rud m t f th se teeth.[21] Stall ns ha e mall cai teeth which are tl qu te abse t r dim ntary in th m re b t tl ey d not ppe to be used figl ti g fo tall b te w tl tl ir incisors, and d n t open tl m this w l l k m ls and anacoes. Wl th ad lt m l po sesse ann w fficı nt whilst tl e f male l as tl r n m re rud m ts, w m y co l d th t th arl mal p g nito of tl pec was pro ded w th ffici t ca s, which l a e bee partially transf rred to th f m les Tl red t f th teetl in th mal seems to ha f ll wed from som chang in thei man

[20] Pallas, *Spicilegia Zoologica*, fasc. xiii., 1779 p 18

[21] Lamont, *Seasons with the Sea-Horse* 1861 p. 141

also Falco (*Pal nt M m nd V te* L 1868, p 5 6) ca nes adult f m l dee l ld males of th musk-dee tl ca es (P llas, *Spic Zoolog* fasc. xi 1779 p. 18) som tim grow t th le gth of three iches, hilst ld f males rudim t projects scarc ly half inch abo the gums.

informs me both as to red-deer and fallow-deer that in fighting they suddenly dash together *and getting their horns fixed* against each other s bodies a desperate struggle ensues When one is at last forced to yield and turn round the victor endeavours to plunge his brow antlers into his defeated foe It thus appears that the upper branches are used chiefly or exclusively for pushing and fencing Nevertheless in some species the upper branches are used as weapons of offence when a man was attacked by a wapiti deer (*Cervus canadensis*) in Judge Caton s park in Ottawa and several men tried to rescue him the stag never raised his head from the ground in fact he kept his *face almost flat on the ground* with his nose nearly between his fore feet except when he rolled his head to one side to take a new observation preparatory to a plunge In this position the ends of the horns were directed against his adversaries In rolling his head he necessarily raised it somewhat because his

of 1 0 or 200 feet and the attacked man was killed [6]

Although the horns of stags are efficient weapons there can I think be no doubt that a single point would have been much more dangerous than a branched antler and Judge Caton who has had large experience with deer fully concurs in this conclusion Nor do the branching horns though highly important as a means of defence against rival stags appear perfectly well adapted for this purpose as they are liable to become interlocked The suspicion has therefore crossed my mind that they may serve in part as ornaments That the branched antlers of stags as well as the elegant lyrated horns of certain antelopes with their graceful double curvature (fig 64) are ornamental in our eyes no one will dispute If then the horns like the splendid accoutrements of the knights of old add to the noble appearance of stags and antelopes they may have been modified partly for this purpose though mainly for actual service in battle but I have no evidence in favour of this belief

An interesting case has lately been published from which it appears that the horn of a deer in one district in the United States are now being modified through sexual and natural selection A writer in an excellent American journal[7] says that he has hunted for the last twenty-one years in the Adirondacks, where the *Cervus virginianus* abounds About fourteen years ago he first heard of *spike-horn bucks* These became from year to year more common about five years ago he shot one and afterwards another and now they are frequently killed The spike horn differs greatly



FIG 64 St ps eros h d (from S r A drew Sm th s *Zoology f S th Af*)

from the common antler of the *C* rv g *a ius* It consists of a single pike more slender than the antler and scarcely half so long projecting for and from the brow and terminating in a very sharp point It gives a considerable advantage to its possessor over the common buck Besides enabling him to run more swiftly through the thick woods and underbrush (every hunter knows that does and yearling bucks run much more rapidly than

[6] See a most interesting account in the Appendix to Hon. J D Caton paper above quoted.

[7] *The American Naturalist* Dec 1869 p. 552.

from various sources. F mal dogs, m sured t the sh ld r range from 8 ncl es, hich is l w t 33 n 34 ncl s in l e ght and w ght from 80 po ds, wl cl s l gl t, t e mo e. Th f m l s

poun
9 to 100 pound f r the mal and 0 for the f male, ould be saf r b t th re reason to beli that f rm ly both sex s t tained gre te w ight. M C ppl l as ghed p pp es wh n f tmgl t ld in n l w lt f f mal

pe ce goe d g p pp as a rul d n r ry l ttl from b tch t ll th y rri e t bo t 6 six m ths ld and tl n th d g b gin to increase g ining po th b t l s b th in ght and size At b th and f se e l eeks aft rward b tcl p ppy w ll occ

males d t tta n tl f ll growth t i t y ar ld th gh th f m l ttain t soo Accord g t M C ppl pen ence mal d g g grow g t t re t ll th are from tw l t ghtee m ths ld and ght till f m gl teen t t nty f ur mo ths ld whilst th f m les cease increasing t ture t th g f f m m t f rteen fiftee m ths, and ght t th a f from tw l to fifteen month From th se no tat m t t l th t tl f ll diff re ce ze betw th m l and f mal Scot h dee l und t acq red t l th lat hf Th mal alm t lus ly are sed f co rsing f as M M N ill nf ms m th f males h t ffi t tre gth and w ght to pull d wn f ll gro n dee

See also Richardso *M al th D g* p 59 Much aluabl f rm ti th Scottish dee hound gi en by M McN ill, h first alled t ten io t the equal ty size bet ee th se es, Scr pe *Art of D er S alk g* I h pe th t M C pples ill keep t h t t of p bl h g full ccou t nd history of this f us breed.

From the name used in old legends, it ap pe rs as I hear f m Mr C pples th t t a v ry anci nt period tl e males we e tl mo t cel l ated tl e f mal s b i g ment oned only as tl th r of fam us d gs. Hence during many genc at ns t is the mal wl icl l as be ch efly te ted f r tre gth ize peed and co ge and the b t w ll ha e be n bred f m ls l we er the m l s do n t tta n the r full d men ons until r th r late n l f th y will ha tend d n accord ce with the law ft n i d c ted t tra m t th l a t rs to tl m l ff pring l ne and tl us th gre t qual ty b tween the sexes f the Scotch dee h und may probably be cco nted f



Fig. 65 H ad f comm n ld boar in prim f lf (from B hm)

The mal s f som f w q adrupeds poss s g n o p ts d l ped sol ly as m ans f d f ce gainst th ttacks f th m l s Som kind f dee use as w h e seen, th ppe bra ch f th h rns chi fly l ly f d f nding tl msel es and tl Oryx ant l pe as I am nf med by M Ba t l tt f nce m t kilf lly w th h lo g g ntly ed h rns but th se are l k wise sed as rg n f ff nce Th sam bserv remarks th t hi ocero n fight g parry ch oth s d l g bl ws w th th h rn l ch clatt l dly tog th as d th t ks f boars Alth gh wild boars fight d p t ly th y seld m accord g t B hm rece f tal w unds as th bl w fall ach th tusks n th lay f gristly kin co ring th h ld lled by th G rman hunters th sh ld and h re w h p t pe ally modified f d f ce W th bo rs th p m f lf (see fig 6) th t ks in th l w y w are used fo fight g b t th y become in old g as Brehm t t s, so m ch rved ward

ner of fighting often (but not in the horse) caused by the development of new weapons

Tusks and horns are manifestly of high importance to their possessors for their development consumes much organised matter A single tusk of the Asiatic elephant—one of the extinct woolly pecies—and of the African elephant have been known to weigh respectively 1 0 1(0 and 180 pounds and even greater weights have been given by some authors [32] With deer in which the horns are periodically renewed the drain on the constitution must be great [1]

u

u —the skull of the latter weighing on an average only five pounds and a quarter Although the horns are not periodically renewed in sheep yet their development in the opinion of many agriculturists entails a sensible loss to the breeder Stags moreover in escaping from beasts of prey are loaded with an additional weight for the race and are greatly retarded in passing through a woody country The moo e for instance with horns extending five and a half feet from tip to tip although so skilful in their u e that he will not touch or break a twig when walking quietly cannot act o lexterously whilst rushing away from a pack of wolve During his progress he hol l his no e up so as to l y the horns horizontally back and in this attitude cannot see the ground distinctly [34] The tips of the horns of the great Irish elk were actually eight fe t apart! Whilst the horns are covere l with velvet which lasts with re l deer for about twelve weeks they are extremely sen itive to a blow so that in Germany the stags at this time somewhat change their habits and avoiding dense fo est fre quent young woods and low thickets [35] The facts remind us that i ial birds have ac quired ornamental plum s at the cost of retarded flight and other o naments at the cost of some lo s of power in th ir battles with rival male

With mammal wl en as is often the se the sexes differ in ize the males are aln st always larger and tronger I am inf rmed by Mr Gould that this holds good in a marked manner with the marsupials of Australia, the males of which appear to continue growing until an unusually late age But the most extraordinary case is that of one of the seals (*Callorhinus ursinus*) a full grown female weighing less than one sixth of a full grown male [36] Dr Gill remarks that it is with the polygamous seals the males of which are well known to fight avagely together that the sexes differ much in size the mon gamous pe cies differing but little Whales al o aff rd evidence of the relation existing between the pugnacity of the males and their large size compared with that of the female the males of the right whales do not fight together and they are not larger but rather smaller than their females on the other hand male perm whales fight much together and their bodies are often found scarred with the imprint of their rival s teeth and they are double the size of the females The greater strength of the male as Hunter long ago remarked [37] is invariably displayed in those parts of the body which are brought into action in fighting with rival males—for instance in the ma ive neck of the bull Male quadrupeds are also more courageous and pugnacious than the females. There can b little doubt that the e characters have been gained partly through sexual selection owing to a long series of victorie by the stronger and more courageous males over the weaker and partly through the inherited effects of use It is probable that the successive variations in tr ngth ize and courage wh th r due to mere variability or to the ef fects f u e by the ccumulati n f which male qua lrupe l have acquired these char act ri tic qualitie occurr l rath r l te in life and were cons quently to a large extent limited in th ir t an n ion t th same sex

Fr m th ese c n l r ti n I was anxious to obtain infor iati n as to th Scotch leer hound th sex of hich liff s re m r e than th o e f any oth er breed (th ugh blood houn l liff n l ll)

J (s

u tt l r l x l l a with great kindness llecte l f r t th f ll n g f cts

[32] Em rson T m nt *Ceyl* 1859 l p 275 O *B it h F ssil M mal* 1846 p 24

[34] Rich dso *Fa a B* (*a* th m ose *H ial at* pp 236 237 th of th h rns *La d d W t* 1869 p 143 See l so O e *British Fossil M mal* th l l lk 11 447 4

[35] *Fo est C eat es* by C Bo r 1861 p 60

[36] See th y t reat g paper by M J A All *B ll M* (*m* *Zoology f C* ml *(g* l *t d* *S(l* l N l l 82 ll 4l l er t ll f l l sers (t ll y t Dr G ll *Th* l N *l al t J* ua y 18 l Ind l l th l t f th r f hales *Ir ar N l al t J* uary 18 3

[37] *A* *al Economy* p 45

scored and abraded in an e t aordinary man ner

Alth u h th males of so man members of the p g family are provided with w pons, and as ha just seen w th m ans f d fe ce these weapons seem to h e been acquired within a ath lat geological period D Forsyth M j spec fic u se al m oc n species, in f whi h do th tusks ppear to ha been largely d l ped in the mal and Professor R tim yer was f rme l struck with this sam fact.

F a. 67 Head of female Eth p w rt h g from P oc ed g f the Zoolog al Society 1869 h g th sam chara t rs as th male, though red ced scale.
N B Wh th gra g was first made, I was und th impressi that t rep se ted th m le.

The mane of th l f a good def nce against the ttacks f al l ns, th dang to wh ch h liabl f th mal s, as Sir A. Smith inf rm m n g in te ribl b ttles, and y ung l dar n t pp ach an ld I 18 tig t Bromwi h brok into th ca f h and fearf l sce n

lynx (F l ca ad is) is m ch l ng in th mal than in th f m l b t wh th t serves as d f nce I d t kno Mal seals are w ll kn wn t fight desperately t g th nd th males of cert in kinds (Ot ria j bata) ha

gre t mane whilst the female have small nes or n ne. The mal baboon f the C pe of Good Hope (*Cynocephalus porcarius*) has a much longer mane and larg r canin teeth than the femal and th mane probably serves as protecti n, f r on aski g th keepers in the Zool g cal Gard n witho t giving them any cl e t my object, wl eth r any of the monkeys pecially ttacked each oth r by the n pe f th neck, I was answ red th t this was n t the case ept w th the abov baboon In the Hamadryas b boon, Ehrenberg com pares th mane f the ad lt male to that f a y ung lion, wh lst in the y ung f both sexes and in th e f male the mane is alm t absent.

It appe red to m p obable that the imm nse woolly man f th male American bison, which reaches lm t to th e ground, and is much more d l ped in the mal s than in th f males, erved as a protection to th m n the terr bl b ttl but an xperienced h te t ld J dg C ton that h had ne er ol served any th ng which fa ed thi beli f The talh n has th ck r and full mane than the mare and I h made part cular inq ries f two gre t train rs and breeders, who h ve had cl rg f many ture horses, and am assured that they in ariably ndea o to seize anoth r by th neck. It does n t, h w f ll w from th f reg g tat m nts, that wh n th hair n th neck serv as a d fence that t was riginally d loped f this pur pose th gh this is probabl in some cases, as that f th h n. I am informed by M Mc N ll th t th l ng hairs n th throat f th tag (C rvus laph) serv as a great protec ti n t him wh n l nted f th do g n ally nd ur to seize him by th thro t b t t is n t prob bl th t th se hair w re pecially d l ped f this p rpose th rwise th y g and th f males w uld hav been eq ally p tected.

Choice i P n g by eithe S x f Q adru-ped —Bef re describ g in th next chapte the d ff rences between th se es ce

tti della Soc It liana d S Nat. 1873, 1 fasc.

The T me Nov 10 1857 In re ard t the C nada lynx, see Aud bo nd Bachman, *Quadrupeds f North A erica*, 1846, p 139.

D Murie, Naria, *Proc. Zoolog Soc* 1869 p 109 M J A. Allen, the paper abo q ted (p. 75) d ubts heth th hair whi h is l ger the eck the mal tha in th f male, deserves to be called ma e.

and upwards over the snout that they can no longer be used in this way They may how ever still serve and even more effectively as a means of defence In compen at on f he loss those a little

laterally increase in old age so much in length and curve so much upwards that they can be used for attack Nevertheless an old boar is not o dangerous to man as one at the age of six or seven years [39]

In the full grown male Babirusa pig of Celebes (fig 66) the lower tusks are formidable weapons like those of the European boar in the prime of life whilst the upper tu ks are so long and have their points so much curled inwards sometimes even touching the forehead that they are utterly u eless as weapons of attack They more nearly resemble horns than teeth and are so manifestly useless as teeth that the animal was formerly supposed to rest his head by hooking them on to a branch! Their convex urface however if the head were held a little laterally would serve as an excellent guard and hence pe haps it is that in old animals they are generally broken off as if by fighting [40] Here then we have the curious case of the upper tusks of the Babirusa



FIG 66 Skull f the Bab rusa I g (from W llace s Malay A h pel o).

... of an boar the lower tusks assume in a less degree and only during old age nearly the same form and then serve in like manner solely for defence

In the wart hog (Phac ch erus æthiopic is f g 67) the tusks in the upper jaw of the male curve upwards during the prime of life and from being pointed serve as formidable weapons The tusks in the low r jaw are sharper than those in the upper but from their hortness it seems hardly possible that they can be used as weapons of attack They must how ever greatly strength n those in the upper jaw from being ground so as to fit closely against their bases Neither the upper nor the lower tusks appear to have been pecially modified to act as guards, though no doubt they are to a certain extent used for this pu pose But the wart hog is not de titute of other pecial means of protection for it has, on each side of the face beneath the eyes, a rather stiff yet flexible cartilaginous oblong pad (fig 67) which projects two or three inches outwards and it appeared to Mr Bartlett and myself when viewing the living animal, that these pads when struck from beneath by the tusks of an opponent would be turned upwards and would thus admirably protect the some hat prominent eye I may add on the authority of Mr Ba tlett that these boars when fighti g tai l directly face to face

...

ans rs to tl fl xil l pad f the wart h g it has also two bo y p n nce on the upper jaw above the no trils A pair of these pecies in the Zool gic l Garden recently broke i t the cage of the wart h g They fought all night long and were f und in the m rning much exh i ted l t n t se i u ly wou led It i a s gnif ca t fact, as sl ewing the purp ses of the above-described proj cti ns and excrescences, that these were covered with blood and were

39 Brehm Th erl ben B ss. 729-32.

40 See Mr W llace i t rest g eco t of this animal, The Mal y Arch pelago, 1869 vol. i. p. 435

t 1 t and p l both f

more remarkabl case n whi h a
nd rl ll t llg t f male t n r l ed a
retn r bel ging to a n ghbo t cl a
degree that h had ft to be d gged w
from h m. Aft r th pe man nt sep t
alth gh repe tedly h g milk in l te t
she ld eve ackn wledg th co tsh p of
any th d g and t the gret f l ow e
ne r bo p pp es. Mr C ppl al t t s,
that in 1868 f mal dee h d in l k l
three prod ced p pp s, and n ach occas n
shewed a marked pref re ce f f th
l l most b t t tl most

th t he has kn wn som tances h cit th
case f f his wn dee h ds, wh w ld
not tak any n t ce f p rt cular f mal
mast ff so that an tl dee l d had t b
mplo ed It ld b pe fl to gi as
I could th instances, and I will ly add
that M Barr h has caref lly bred many
bloodhounds, tat th t in lm t rs in
stance part lar d d ls f pposit se
shew a decided pref re ce f ach th
Finally M C ppl s, aft tt nding to tl
subject f an th has wr tt to me,
I ha had f ll co fi m t n f m f rm
&c. … f g b ced g f un decided
pref rence f ach tl b g ft n
fl ced b size bright col and d d l
haract rs, as ll as b th d gre f th
pre f mil arity

In regard to h rse M Bl nkiron, th gre test breed r f race horses in the wo ld
nf rm t ll n are so f equently
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ally used
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Gladiateu and trick had t be practised
W l al l
ace l
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tl ir
m reject t rse
Mr W ght tabl so that tl e mare had to
be cleated l ro per L cas[44] q tes ariou
tatem t from Fre l tl ts, and re
m ks *On t des ét lons q i ép e nent*
d' e j m nt t négl ge it t t les aut e
He gi e n the uth ty of B l n m lar
fact n regard to bulls and M H Re ks as
re m tl at a f m u l t l rn bull bel ng
g t l f the n ari bly ref sed to b
m t hed w tl black cow H ffb g in
d sc b g tl l m t cated reindeer of L p-
land ay *Fœ æ m j et f ri ma es*
præ cat ri dm it t d eos co f g nt a
j ioribus g tatæ q hos f gam on
j ci nt[45] A l g m wh h s b ed many
p gs, asserts th t sow ft n r ject e boar
and mmed t ly ccept an tl

From tl se facts th re an l do bt tl t
w th m t f u d nest ted q adruped
t g ind d l antipathi s and prefe nces
are f q tly xhib ted and much m com
m nly by th f m l than by th male Th
b ing tl cas t mprob bl that the un ns
f q druped n a tat f nat re sh uld be
l ft t m re ch ce It i mu h m prob bl
tl t th f m l allu ed cited by
p rt lar m l wh po sess ce t in ch
act rs in high d g ee th n oth m l s but
wh t th se ch act ar w an seldom r
n disco w th certai ty

[44] *T ité d l'Heréd.* Vol. t m. 1850 p 296
Amæ itate A ad L 1788 p 160

odours emitted and ornaments it will be convenient here to consider whether the sexes exert any choice in their unions Does the female prefer any particular male either before or after the males may have fought together for supremacy or does the male when not a polygamist select any particular female? The general impression amongst breeders seems to be that the male accepts any female and this owing to his eagerness is in most cases probably the truth Whether the female as a general rule indifferently accepts any male is much more doubtful In the fourteenth chapter on birds a considerable body of direct and indirect evidence was advanced shewing that the female selects her partner and it would be a strange anomaly if female quadrupeds which stand higher in the scale and have higher mental powers did not generally or at least often exert some choice The female could in most cases escape if wooed by a male that did not please or excite her and when pursued by several males, as commonly occurs she would often have the opportunity whilst they were fighting together of escaping with some one male or at least of temporarily pairing with him This latter contingency has often been observed in Scotland with female red deer as I am informed by Sir Philip Egerton and others [4]

It is scarcely possible that much should be known about female quadrupeds in a state of nature making any choice in their marriage union The following curious details on the courtship of one of the eared seals (*Callorhinus ursinus*) are given [5] on the authority of Capt. Bryant who had ample opportunities for observation He says Many of the females on their arrival at the island where they breed appear desirous of returning to some particular male and frequently climb the outlying rocks to overlook the rookeries calling out and listening as if for a familiar voice Then changing to another place they do the same again As soon as a female reaches the shore the nearest male goes down to meet her making meanwhile a noise like the clucking of a hen to her chickens He bows to her and coaxes her until he gets between her and the water so that she cannot escape him Then his manner changes and with a harsh growl he drives her to a place in his harem This continues until the lower row of harems is nearly full Then the males higher up select the time when their more fortunate neighbours are off their guard to steal their wives This they do by taking them in their mouths and lifting them over the heads of the other females, and carefully placing them in their own harem carrying them as cats do their kittens Those still higher up pursue the same method until the whole space is occupied Frequently a struggle ensues between two males for the possession of the same female and both seizing her at once pull her in two or terribly lacerate her with their teeth When the space is all filled the old male walks around complacently reviewing his family scolding those who crowd or disturb the others and fiercely driving off all intruders This surveillance always keeps him actively occupied

As so little is known about the courtship of animals in a state of nature I have endeavoured to discover how far our domesticated quadrupeds evince any choice in their unions. Dogs offer the best opportunity for observation as they are carefully attended to and well under tood Many l ree [illegible]

[illegible] r them as they are known to be in other case where higher animals are concerned Bitches ar not always prudent in th ir loves but are apt to fling themselves away on curs of low degree If reared with a companion of vulgar appearance there often springs up betw en the pair a devotion which no time can afterward [illegible] for such it really [illegible] become of a more than romantic endurance Mr Mayhew who attended chiefly to the smaller breeds is convinced th t the f male are strongly attracted by males of a large size [6] The well known veterinary Blaine stat s that his own female pug dog became so attached to a spaniel and a femal setter to a cur that in neither case would they pair with a dog of their own bree until several weeks had el psed Two similar and trustworthy accounts have been giv n [illegible]

[4] Mr B[illegible] in his excellent description of the habits of the red-deer [illegible] (*Proc. Cal.* [illegible] 1861 p 81) says [illegible] the stag [illegible] the sanctuary of the harem [illegible] trophy [illegible] trophy Exactly the same thing occurs with the seals see Mr J A Allen *ibid.* p 100

[5] Mr J A Allen in *Bull Mus Comp. Zoology* of Cambridge United States [illegible] No. 1 p. 99

[6] *Dogs their Management*, by E Mayhew M.R.C.V.S. 2nd ed 1864 pp 18 192.

[7] Quoted by Alex Walker *On Intermarriage* 1838 p 2[illegible]6 see also p 244

pect se es as sex l ha m b
ha e t ecur t th l ject th n t chap-
t Th ocal g f tl Am ca *M j t s*
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the f mal l a d rf lly p f l
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f t so l t g d u g w th
the l lmi g ce Th m l beg n
th d adf l rt, d ft co t n e t

pcua ısı no ..
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prod ced f l ack ds and rise t
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figl t f ri usly on th ı e and tl eir roari g s
said to be s met mc so l d as to be heard
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ali t b lie tl at tl e ce ı tl us trength
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wl k lled 600 f tl e mimals th hood is
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Odo —W tl so n animal as tl tl e
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ı g od l l tl y m t pp r t serve
l ly as l f n e W th l e m e

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l ss, tl gland bec nlar ed ı tl mal s

tl pec the glan d re confi ed to tl e
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al l pl t nl rg d m t a secret n
l g t g m ky odo Th male and
ly th f mal s, f m ny k d f b t h ve
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ar us part and t b l ed tl t tl se
od f
Tl k fll ı m f the male g t well
kn and tl t f ta n m l d e n

*C L M rt n, *G neral Int od ctio to the Nat al History of M mm. A als*, 1841 p 451
Naturg schichte der Sä g hier 1830, ss. 15 21

P gu y b ince O b ts, M D bson, *I oc ed g f th Zoolog cal Society* 1873 p 241

CHAPTER XVIII

SECONDARY SEXUAL CHARACTERS OF MAMMALS—*Continued*

QUADRUPEDS use their voices for various purposes, as a signal of danger, as a call from one member of a troop to another, or from the mother to her lost offspring, or from the latter for protection to their mother; but such uses need not here be considered. We are concerned only with the difference between the voices of the sexes, for instance between that of the lion and lioness, or of the bull and cow. Almost all male animals use their voices much more during the rutting season than at any other time; and some, as the giraffe and porcupine,[1] are said to be completely mute excepting at this season. As the throats (i.e. the larynx and thyroid bodies[2]) of stags periodically become enlarged at the beginning of the breeding-season, it might be thought that their powerful voices must be somehow of high importance to them; but this is very doubtful. From information given to me by two experienced observers, Mr. McNeill and Sir P. Egerton, it seems that young stags under three years old do not roar or bellow; and that the old ones begin bellowing at the commencement of the breeding-season, at first only occasionally and moderately, whilst they restlessly wander about in search of the females. Their battles are prefaced by loud and prolonged bellowing, but during the actual conflict they are silent. Animals of all kinds which habitually use their voices utter various noises under any strong emotion, as when enraged and preparing to fight; but this may merely be the result of nervous excitement, which leads to the spasmodic contraction of almost all the muscles of the body, as when a man grinds his teeth and clenches his fists in rage or agony. No doubt stags challenge each other to mortal combat by bellowing; but those with the more powerful voices, unless at the same time the stronger, better armed, and more courageous, would not gain any advantage over their rivals.

It is possible that the roaring of the lion may be of some service to him by striking terror into his adversary; for when enraged he likewise erects his mane and thus instinctively tries to make himself appear as terrible as possible. But it can hardly be supposed that the bellowing of the stag, even if it be of service to him in this way, can have been important enough to have led to the periodical enlargement of the throat. Some writers suggest that the bellowing serves as a call to the female; but the experienced observers above quoted inform me that female deer do not search for the male, though the males search eagerly for the females, as indeed might be expected from what we know of the habits of other male quadrupeds. The voice of the female, on the other hand, quickly brings to her one or more stags,[3] as is well known to the hunters who in wild countries imitate her cry. If we could believe that the male had the power to excite or allure the female by his voice, the periodical enlargement of his vocal organs would be intelligible on the principle of sexual selection, together with inheritance limited to the same sex and season; but we have no evidence in favour of this view. As the case stands, the loud voice of the stag during the breeding-season does not seem to be of any special service to him, either during his courtship or battles, or in any other way. But may we not believe that the frequent use of the voice, under the strong excitement of love, jealousy, and rage, continued during many generations, may at last have produced an inherited effect on the vocal organs of the stag, as well as of other male animals? This appears to me, in our present state of knowledge, the most probable view.

The voice of the adult male gorilla is tremendous, and he is furnished with a laryngeal sack, as is the adult male orang. The gibbons rank among the noisiest of monkeys, and the Sumatra species (*Hylobates syndactylus*) is also furnished with an air sack; but Mr. Blyth, who has had opportunities for observation, does not believe that the male is noisier than the female. Hence, these latter monkeys probably use their voices as a mutual call; and this is certainly the case with some quadrupeds, for instance the beaver.[4] Another gibbon, the

[1] Owen, 'Anatomy of Vertebrates,' vol. iii. p. 585.
[2] Ibid. p. 595.

[3] See, for instance, Major W. Ross King ('The Sportsman in Canada,' 1866, pp. 53, 131) on the habits of the moose and wild reindeer.
[4] Owen, 'Anatomy of Vertebrates,' vol. iii. p. 600. Mr. Green, in 'Journal of Linnean Society,' vol. x. Zoology, 1869, note 5.

aray re tl d l g n th mal tl an m the f m le an l w nd rf ll po e ful. These m nk y n warm w the mak the for ts reso d t m g and e m g th the l lm g ce Th mal s begin

they d light tl d t y to xcel ach tl Wheth m t f th f go- ing m k l acq red th po f l ices rd to b t th r n als and harm the f male — wheth the ocal g ns

seems tl m t p b l l

I m y h m t t ry n s sexual peculiariti occ rn g i se ls, beca se th y ha bee pposed by som writ rs t ffect th ice Th se f tl m l sc l pl t (*Macrorh us p bosc d*) becom g tl lo g ted d n g th breed ason, l an th b rected l th t t t som tim foot in l th Fl f m l t tl us pro ded t y p nod f l f Tl n al mak ld l oarse, gu gl g se wl ch d bl at great distan e d b l cdt l t gth ed b th p bosc th f th f ual be g diff t. Le so co p re tl ect

fight f n sly n the ce, and tl e r roaring s said to be som times so loud as to be heard f u mil s off When ttacked tl y likewise r ar r b ll w nd whe e er i r tated the bladd r nflated and qui e s Som natur alist b l tl t th oice s tl us strength ned b t ar s othe uses h be n as- s gned t tl e traordi ary tructure Mr R Brown tl ks tl t it serv s as a prot ct n ag t acc le ts of all kind but thi i n t p b bl f as I am ass ed by Mr Lam nt wh killed 600 f th se nim l the hood s r di uta y n th f m l s, and t ot de l ped n tl m l d ring y tl

Odo r —W tl some animals, as itl the ot u kuk of Am a, tl e ov rwl elm ng odo wl i l they m t ppears to serve el h as l f nc W th l ew m ce (So e) botl se e poss ss abdo nal scent gland d tl can be l ttl d l t from th ject n f tl bodi by b rd d beasts of p tl t tl od p tecti rthe l s, tl gland becon enlarged tl male d ng tl l eed g as In many tl er q druped tl glar d ar f the sam n b th se s, l t th i se are not k wn In tl pec e th glar ds confined to tl e mal s, o re more d el ped th n n the fe i

mal l pl nt nlarge, and m t a secret n l a g tro g m k y od Th mal s, and ar ly th f mal s, f m y k ds of b ts h gl d d protr d bl sacks tu ted n ar pa t and t s b l ed tl t th se od rif ro

Th k fflu m f th male goat w ll kn n and tl t of ce ta n mal d r i d f lly tr g d p rs t t. O th banks f tl Pl ta I percei ed tl ai tainted w th the od f tl mal C rr *mpe tris* t h lf

prod ced far l ack ard and rise t an t nal t se h in l ght Tl hood is lotl ed w tl h t l d m scular t can b nfl ted til t m tl an eq al th hol h ad ze Tl mal l rutting,

K L M rt n, *G neral Introd ctio to the Natural History of M mm. A mals* 1841 p. 431

Naturg schichte der S geth er ro P gu y 1830, ss. 15 21

br m ce O bats, Mr D bso *I roce d g f th Zoological Society* 18 3 p 241

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[5] Mr. Green, in *Journal of Linnean Society*, vol. x., *Zoology*, 1869, p. 362.

pends from th neck and pper hal e of the legs b t M Bartl tt does not b l e that this mantle is of th l ast se t tl e m l in hom t s m ch m re d l ped th n in the f male

Male quadrupeds of many kind d ff r from the femal in havin more l air r l air f a diff re t charact on certain part f th r faces. Thus th b ll al n has cu led hai n the foreh ad[15] In three l sely ll ed ub g ne f th goat family nly tl mal possess beards som t m f lar in two ther b-g a both sex s ha a b ard but of l r ab t the face and h ad are alike in both sexes.

Tl e mal s f ariou membe s f th ox famil (B dæ) and of certain ant l pes, are f rnisl ed w tl d l p or g eat fold of skin on tl neck wh ch is much less de eloped in tl female

t w th respect

N w

tos h

p te

r tl e u w p

l g th b k f certa n m l antelopes, are f any use t tl em in tl ir rdinary l ab ts. It s poss ble th t the mmens beard of the m le P thecia an l th larg beard f th mal o ang m y protect tl i throats wh n figl ting f r th keeper n tl Zool gical Gardens i f m m tl t n ar monk y ttack h tl by tl e thro t b t t n t prob ble that th b ard l as been d l ped fo a d t t p rpose from tl at served by th whisk rs m us tacl e and tl e t fts of l a n tl face and no n w ll ppose tl t tl ese are usef l as a protect n Mu t we at tribut ll th se ppend g of ha kint m re p rpos l ss an b l ty in th male It an n t b l n ed tl t this is po bl f mar y d m t cated q adrupeds, ce t n cl aract rs, ppare tl n t d ri ed througl re rs f m an w ld pare t f rm confi ed t th m l s, are m re l l ped n th m than in tl f males—f t ce tl h n p n the mal b se ttl f Ind th tail f f t t led ams, th arcl ed tl f tl f rel d tl m l f se l breed f heep d lastly tl m n th l g l rs th l d l s, and th d w l p f th m l f th B bu goat.[18] The m wh l occu only th am f an M an breed f heep tru seco d y se ual l act f as I h ar from M W wood Read t n t d l ped if th an mal b cas t ted Alth gl we ht t b tr m ly t as l wn in my w k I riat n

F 68 *Pith ci at as m le* (from Brehm)

rud m tar W th so k tl b rd is u f ed t tl mal as tl m l larg tl l tl tl f l as tl *Mycete y* and *I tl t as* (fi 68) So t th tl h k rs f som pe ies f Macac s, and a ha seer w th th man f som pec f b boons. B t tl m t ki d of m nk tl riou t ft

[15] H ter *F say nd Observ t ns* ed ted by O ri 1861 ol. p 236

[16] See D Gray *Catalogue f M mmal the B ish M seum*, part iii., 1852, p. 144

[17] R ngger *S gethiere* &c., s. 14 Desmarest, *M mmalogie* p 56

[18] See th h pt rs th se eral mals l. of my I *at f A mal nder D m ticatio* also vol. p 3 lso h p th p tice f select by sem -ci lised people. F th B buar goat, see D Gray *Cat log bid.* p. 157

mile to leeward of a herd and a silk handkerchief in which I carried home a skin though often used and washed retained when first unfolded traces of the odour for one year and seven months This animal does not emit its strong odour until more than a year old and if castrated whilst young never emits it.[10] Besides the general odour n ole

Bos

er

p an i goats possess odoriferous glands in various situations more especially on their faces The so-called tear sacks, or suborbital pits come under this head These glands secrete a semi fluid fetid matter which is sometimes so copious as to stain the whole face as I have myself seen in an antelope They are usually larger in the male than in the female and their development is checked by castration [11] According to Desmarest they are altogether absent in the female of *Antilope subgutturosa* Hence there can be no doubt that they stand in close relation with the reproductive functions They are also sometimes present, and sometimes absent, in nearly allied forms In the adult male musk-deer (*Moschus moschiferus*) a naked space round the tail is bedewed with an odoriferous fluid whilst in the adult female and in the male until two years old this space is covered with hair and is not odoriferous

is a singular fact that the matter secreted by this latter gland does not, according to Pallas change in consistence or increase in quantity in a at

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uuction He gives, however only a conjectural and unsatisfactory explanation of its use

In most cases when only the male emits a strong odour during the breeding season it probably serves to excite or allure the female We must not judge on this head by our own taste for it is well kno e enticed

th er on

some

by certain essential oils, and cats by val substances far from agreeable to us and dogs, though they will not eat carrion, and roll on it From the reasons given discussing the voice of the stag we may the idea that the odour serves to bring th males from a distance to the males. Active long-continued use cannot here have c into play as in the case of the vocal orga The odour emitted must be of considera importance to the male inasmuch as large a complex glands, furnished with muscles f everting the sack and for closing or openi the orifice have in some cases been develope The development of these organs is intelligible through sexual selection if the mo odoriferous males are the most successful in winning the females, and in leaving off prog to inherit their gradually perfected glands and odours.

Development of the Hair —We have seen that male quadrupeds often have the hair on their necks and shoulders much more developed than the females and many additional instances could be given This sometimes serves as a defence to the male during his battles but whether the hair in most cases has been specially developed for this purpose is very doubtful We may feel almost certain that this is not the case when only a thin and narrow crest runs along the back for a crest of this kind would afford scarcely any protection and the ridge of the back is not a place likely to be injured nevertheless such crests are sometimes confined to the males, or are much more developed in them than in the females. Two antelopes, the *Tragelaphus scriptus* [3] (see fig 0 p 556) and *Portax picta* may be given as instances. When stags and the males of the wild goat are enraged or terrified these crests stand erect but it cannot be supposed that they have been developed merely for the sake of exciting fear in their enemies. One of the above-named antelopes, the *Portax picta*, has a large well-defined brush of black hair on the throat, and this is much larger in the male than in the female In the *Ammotragus tragelaphus* of North Africa, a member of the sheep family the fore-legs are almost concealed by an extraordinary growth of hair which de-

a to y f t brat L p 632.

See Is Dr Mu es ob rvat s o th se gla d n th *Proc Zool g Soc* 18 0 p 340 Desmarest, On th *Antilope s lg tt osa, M mmal g* 1820 p 455

[11] Pallas, *Spicil g Zoolog* f sc. x 1 9 p. 24 Desm ulins, *Dict. Clas d Hist. Nat.* t m p 586

D Gray *Gle g f m th M nageri t Know l y* pl. 28.

J lg Cat th wap ti, *T ans ct. Ottaw A d N t S* 1868, pp 36 40 Blyth, *Land and Wat n C j ag g us*, 186 p. 37

brown shad abo e whilst the femal who ac quires her adult tints arlier in life than the male, is dark gre abo e, the ung of both sexes being of a deep chocolate colour The male of the north rn *Phoca groenland ca* is a grey with a curious saddle-shaped dark mark on the back th f mal is much smalle

pure white, and can hardl be distinguished among the icy hummocks and sn w their col our thus acting as protection. [28]

With ruminants sexual diff rence of colour occur more commonly than in any oth r rd r

In the Indian black buck (*A bezoartica*) which bel ngs t an the tribe of antelopes th mal is ry dark, almo t black whilst the h rnless f male is f wn-coloured W meet in this pecies, as Mr Bl th inform me, with an exactly similar seri of facts, as in the *Portax picta* namely in the male period call chang ing col u during th breeding season, in the effects f masculati n on this change and in the young of both sexe being indistinguish able from ach th In the *Antilope n ger* the male is black, th f male, as well as th oun of both se es, being brown in *A n g-n g* th male is much bright r coloured than the horn less f male and his chest and bell are blacker th m l *A caama*, the marks and lines

on the throat, th white marks n th f ttocks, and the black spots n th ars all much more

mal are nearly the sam as th se of th fe male onl deepe and f a brighter h [29] Oth anal us cases could be added

Th banteng bull (*Bos d cus*) of the Malayan Archipelago is alm t black, with whit l gs and b ttocks th cow is of a bright dun, as are th ung males until bout th age f three ears, when th y p dly change colour The masculated bull re rts to the colou of th f mal Th f mal kemas goat is pal and both t and the f male *Capra ag grus* are said to be mo unif rmly tinted than th mal s. Dee rarely present an sexual diff rences in colour J dg Caton, h w uf ms m that in th males of th w piti dee (*Cerru adensis*) th neck, bell and legs are much dark than in th fe mal b t d rin th w nt the darke tints graduall fad aw and disappear I may here mention that Judg Caton has in his park three races of th Virginian dee which diff rs slightl in colour b t th diff rences are al most exclusi l confined to th bl winte o breeding-coat so that this case may be com pared with those gi n in a pre us hapt f losel al ed rep esentati species f birds, which diff from each th only in

fact, as vid nce that the colouring of the Portax is of sexual origin, becomes ob io s, when we hear[30] that ne th th red summ coat nor the blue wi t -coat of th Virginian deer is at all affected b emasculation. W th most or all of the highl orname ted species of Tragelaphus the males are darker than th hornless females, and their crests of hair are more fully dev loped In the mal of that magnificent ant lope, th D b an eland th b l is redde the whole neck much blacke and the white band which separates these col ours broad than in th f male In th C pe land, also the male is sl htl dark than the female [31]

Dr Muri the Otaria, *Proceed g Zoological Society*, 1869 p 1 Mr B Bro n the P

Menagerie of Knowsley. Each there is splendid dra ng of the *Oreas derbia* as see the text Tra-

gelaphus. For the C pe land (*O as canna*), see Andrew Smith, *Zoology f S Africa*, pls. 41 d 42. There are lso ma y of these telopes in th Zoological Gardens

[30] On the *A n ger* see *P c Zool. Soc* 1850 p 133 W th respect t alied species, hich ther is equal sexual difference colour see Sir Baker *The Albert Ny nza*, 1866 ol. ii., p. 627 For the *A n g-n g* Gray *Cat. B Mus* p 100 Desmarest, *M mmalogie* p. 468, th *A caama*. Andrew Smith, *Zoology of S Africa*, n th gnu.

under Domestication in concluding that any character even with animals kept by semi civilised people has not been subjected to selection by man and thus augmented yet in the cases just specified this is improbable more especially as the characters are confined to the males or are more strongly developed in them than in the females If it were positively known that the above African ram is a descendant of the same primitive stock as the other breeds of sheep and if the Berbura male goat with his mane dewlap &c is descended from the same stock as other goats then assuming that selection has not been applied to these characters they must be due to simple variability together with sexually limited inheritance

Hence it appears reasonable to extend this same view to all analogous cases with animals in a state of nature Nevertheless I cannot persuade myself that it generally holds good as in the case of the extraordinary development of hair on the throat and fore legs of the male Ammotragus or in that of the immense beard of the male Ithecia Such study as I have been able to give to nature makes me believe that parts or organs which are highly developed were acquired at some period for a special purpose With those antelopes in which the adult male is more strongly coloured than the female and with those monkeys in which the hair on the face is elegantly arranged and coloured in a diversified manner it seems probable that the crests and tufts of hair were gained as ornaments a I I T ic

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Colour of the Hair and of the Naked Skin —I will first give briefly all the cases known to me of male quadrupeds differing in colour from the females With marsupials as I am informed by Mr Gould the er

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m e are re I [1] In the *Didelphis opossum* of Cayenne the female is said to be a little more red than the male Of the rodents Dr Gray remarks African squirrels es

pecially those found in the tropical region have the fur much brighter and more vivid at some seasons of the year than at others, and the fur of the male is generally brighter than that of the female [20] Dr Gray informs me that he specified the African squirrels because from their unusually bright colours they best exhibit this difference The female of the *Mus minutus* of Russia is of a paler and dirtier tint than the male In a large number of bats the fur of the male is lighter than in the female [21] Mr Dobson also remarks with respect to these animals Differences depending partly or entirely on the possession by the male of fur of a much more brilliant hue or distinguished by different markings or by the greater length of certain portions are met only to any appreciable extent in the frugivorous bats in which the sense of sight is well developed This last remark deserves attention as bearing on the question whether bright colours are serviceable to male animals from being ornamental In one genus of sloths it is now established as Dr Gray states that the males are ornamented differently from the females—that is to say that they have a patch of soft short hair between the shoulders which is generally of a more or less orange colour and in one species pure white The females on the contrary are destitute of this mark

The terrestrial Carnivora and Insectivora rarely exhibit sexual differences of any kind including colour The ocelot (*Felis pardalis*) however is exceptional for the colours of the female compared with those of the male are *moins apparentes le fauve étant plus terne le blanc moins pur les raies ayant moins de largeur et les taches moins de diamètre* [22] The sexes of the allied *F mitis* also differ but in a less degree the general hues of the female being rather paler than in the male with the spots less black The marine Carnivora or seals on the other hand sometimes differ considerably in colour and they present as we have already seen other remarkable sexual differences Thus the male of the *Otaria nigrescens* of the southern hemisphere is of a rich

[1] *Osphranter rufus* Gould *Mammals of Australia* 1863 vol ii On the Didelphis Desmarest, *Mammalogie* p 256

I I *d M g* *f N t I H to y N* 1867 p 325 O th M m t D mare t M I g j 04

mp Zool g f M D b I *ed g*

Zoolog I S c ty 1873 p 241 Dr Gray on I th b d 1871 p 436

[22] D t *Mammalogie* 1820 p 220 On *F l s m t* R *bb* *Ind* s. 194

female ho ver th nose at certain gular
intervals of tim becomes ti ted with red

In all the cases hith rto gi en the mal is
more strongly or bright col ured than th
female, and differs from th young f both
sexes. B t as with som f w birds *t is th fe-*
male which is brighte coloured than th male
so with th hesus m nkey (*Macacus he us*)
the female has lar urface of naked skin
round the tail, of brilliant carmin red,
which, as I was assured by th keepers th
Zoological Gard ns, periodically becomes n



Fig. 69 Head of male Mandrill (from Ger
ais, Hist. Nat. d M mm fer)

et more id and h face also is pale red.
On the othe hand, in th adult mal and
the oung of both se (as I saw in th Gar
dens) neithe the naked ki t the post rio
end of the bod no th face sh w trace f
red. It ppears, h w from some p blished
accounts, that the male does occasionally
during certain seasons, xh b t som traces of
the red. Although he is thus less rnam nted
than the female y t in th lar size of his
body lar cani teeth more d loped
hiskers, more promine t superciliary ridges,
he follow th commo rule of th mal ex
celling the female.

I hav n w gi n all the cases kn wn to m
of a diff rence in colour between th sex s of
mammals. Some of these may be th result of
ariat ns confined to on sex and transmitted
to the sam sex, with ut any good being gained
and th refore w th ut the aid of selecti n W
ha e instances of this with our domesticated
animals, as in the males of certain cats being
rusty red whilst th f males are tort ise l ll
coloured. Analo us cases occu in nature M
Bartl tt has seen man black ari t es of th
jaguar leopard, ulpin phalang r and
w mbat and h is ce tain that all, r n arly
all these animals, were males. On the the
hand with w l es, f es, and pparentl
American squirrels, both sexe are occasionally
born black. H nce t is quit possibl that w th

lim ted in th ir transmissio N erth less t
is mprobable that tl d v rsified id, and
co trasted col rs of certain quadrupeds, f
instance f th abo monk s and ant lopes,
can thus be accounted for W sh uld bear n
mind that th se col rs do n t ppear th
mal t birth, b t only t o n ar maturity
and th t unl ke ordinary ariati ns, th y are
lost if th mal be masculated. It is n the
wh l probable that th trongly marked col
rs and oth rname tal haracte of mal
quadrupeds are be ficial to th m n their
ri alry with th mal s, and ha conse
q tl been acquired thro gh sexual selec
tion. This vi w is stre gth ned by th diff
ences in colour between th se es occurring
almost xclusi ly as may be collected from
th pre us d tail, th se *gro ps and ub-*
gro ps f mammals which present th and
stro gly marked secondary sexual characters
these bei likewise du to sexual select n.

Quadrupeds manifestly take n tice f colour
S S. Bake repeatedly observed that th
African lephant and hinocero ttacked
whit grey h rses with pecial fury I h
lsewh re sh wn[22] th t half wild h rses ppar
tly pref to pai with those of th sam
colour and that h rds f fall w-dee of differ
ent colours, tho gh li ing to th ha long
kept distinct. It is more significant fact that
f male zebra w uld n t admit th addresses
f mal ass until h was painted so as to re-

The Variatio of A mals and Plants nder Domestication, 1868, vol. ii., pp. 102, 103.

their breeding plumage [27] The females of *Cervus paludosus* of S America as well as the young of both sexes do not possess the black stripes on the nose and the blackish brown line on the breast which are characteristic of the a lult males [28] Lastly as I am informed by Mr Blyth the mature male of the beautifully coloured and spotted axis deer is considerably darker than the female and thi hue the castrated male never acquires

The last Order which we need consider is that of the primates The male of the *Lemur macaco* is generally coal black whilst the fe male is brow

New World

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in the second year the young male becomes reddish brown in the third black excepting the stomach which however becomes quite black in the fourth or fifth year There is al o a strongly marked difference in colour between the sexes of *Mycetes seniculus* an l *Cebus capucinus* the young of the former an l I be lieve of the latter species re embling the fe males With *Pithecia leucocephala* the young likewise resemble the female which are brownish black above and light rusty re l be neath the adult males being black The ruff of hair roun l the face of *Ateles marginatus* is tinted yellow in the male an l white in the female Turning to the Old World the males of *Hylobates hoolock* are always black with the exception of a wl ite ban l over the brows the females vary from whity brown to a dark tint mixed with black but are never wholly black [30] In the beautiful *Cercopithecus diana* the head of the adult male is of an inten e black whilst that of the female is lark grey in the former the fur between the thighs is of an elegant

the sexes is that the tail of the male is chestnut and that of the female grey but Mr Bartlett informs me that all the hues become more p onounced in the male when adult whilst in the fem le they remain as they were during youth According to the coloured figures given by Solomon Muller the male of *Semnopithecus chrysomelas* is nearly black the female being pale brown In the *Cercopithecus cyn urus* and *griseoviridis* one part of the body which is confined to the male ex is of the mo t bril liant blue or green and contrasts strikingly with the nake l sk in on the hinder part of the bo ly which is vivid red

Lastly in the baboon family the adult male of *Cyn cephalus hamadryas* differs from the fem le not only by his immense mane but slightly in the colour of the hair and of the nal l call sities In the drill (*C le c phaus*) the fem les and young are much paler-col oure l with less green than the adult males. No ther member in the whole class of mam mals i c loure l in so extraordinary a manner as the a lult male mandrill (*C mormon*) The

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the face

s also marked with whitish stripes and shaded in part with black but the colours appear to be variable On the forehead there is a crest of hair an l on the chin a yellow beard *Toutes les parties supé ieures de leurs c isses et le grand espace nu de leurs fesses so t égale ment colorés du rouge le plus vif avec un mélange de bleu qui ne manque réellement pas d élégance* [1] When the animal is excited all the naked parts become much more vivi lly tinted Several authors have used the stronge t

fully le eloped immen e protuberan es of bone are forme l on each cheek wl ich are leeply furro l longitu linally and the naked ski over them is brilliantly-coloured as ju t de cr be l (Fig 69) In the adult females and in tl e young f l th ex s these protuberances are scarcely perceptible and the naked parts are much le s bright coloured the face being almost black tinged with blue In the adult

[27] *Ott ua l ad j f S nc* M y 21 1868 pp 3 5

[28] S Mull tl t g *Zoog I l I n t cl pel* 1839 1844 t b 3 I R ill qu t d by M Blyth n *I d nd H t* 1867

G *H t N t d M m fèr s* 1824 p 103 I gure r gi n f th skull f the m l M D t *H log c* p 0 G Hr St Hil r d F Cu *H t N t des M m f t* 1824 t m

female, however, the face at certain regular intervals of time becomes tinged with red.

In all the cases hitherto given the male is more strongly or brighter coloured than the female, and differs from the young of both sexes. But as with some few birds it is the female which is brighter coloured than the male, so with the rhesus monkey (*Macacus rhesus*) the female has a large surface of naked skin round the tail, of a brilliant carmine red, which, as I was assured by the keepers in the Zoological Gardens, periodically becomes even



FIG. 63. Head of male Mandrill (from Gervais, Hist. Nat. des Mammifères).

yet more vivid, and her face also is pale red. On the other hand, in the adult male and in the young of both sexes (as I saw in the Gardens), neither the naked skin at the posterior end of the body, nor the face, shew a trace of red. It appears, however, from some published accounts, that the male does occasionally, or during certain seasons, exhibit some traces of the red. Although he is thus less ornamented than the female, yet in the larger size of his body, larger canine teeth, more developed whiskers, more prominent superciliary ridges, he follows the common rule of the male excelling the female.

I have now given all the cases known to me of a difference in colour between the sexes of mammals. Some of these may be the result of variations confined to one sex and transmitted to the same sex, without any benefit being thus gained, and therefore without the aid of selection. We have instances of this with our domesticated animals, as in the males of certain cats being rusty-red, whilst the females are tortoise-shell coloured. Analogous cases occur in nature. Mr. Bartlett has seen many black varieties of the jaguar, leopard, vulpine phalanger, and wombat; and he is certain that all, or nearly all these animals, were males. On the other hand, with wolves, foxes, and apparently American squirrels, both sexes are occasionally born black. Hence it is quite possible that with some mammals a difference in colour between the sexes, especially when this is congenital, may simply be the result, without the aid of selection, of the occurrence of one or more variations, which from the first were sexually limited in their transmission. Nevertheless it is improbable that the diversified, vivid, and contrasted colours of certain quadrupeds, for instance, of the above monkeys and antelopes, can thus be accounted for. We should bear in mind that these colours do not appear in the male at birth, but only at or near maturity; and that, unlike ordinary variations, they are lost if the male be emasculated. It is on the whole probable that the strongly-marked colours and other ornamental characters of male quadrupeds are beneficial to them in their rivalry with other males, and have consequently been acquired through sexual selection. This view is strengthened by the differences in colour between the sexes occurring almost exclusively, as may be collected from the previous details, in those groups and subgroups of mammals which present other and strongly-marked secondary sexual characters; these being likewise due to sexual selection.

Quadrupeds manifestly take notice of colour. Sir S. Baker repeatedly observed that the African elephant and rhinoceros attacked white or grey horses with special fury. I have elsewhere shewn* that half-wild horses apparently prefer to pair with those of the same colour, and that herds of fallow-deer of different colours, though living together, have long kept distinct. It is a more significant fact that a female zebra would not admit the addresses of a male ass until he was painted so as to re-

* *The Variation of Animals and Plants under Domestication*, 1868, vol. ii., pp. 102, 103.

semble a zebra, and then as John Hunter remarks she received him very readily In this curious fact we have instinct excited by mere colour which had so strong an effect as to get the better of everything else But the male did not require this the female being an animal somewhat similar to himself was sufficient to rouse him 33

In an earlier chapter we have seen that the mental powers of the higher animals do not differ in kind though greatly in degree from the corresponding powers of man especially of the lower and barbarous races and it would appear that even their t

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o parallel ridges or cicatrices high above the natural surface which unsightly deformities are considered great personal attractions 34—as negroes and savages in many parts of the world paint their faces with red blue white or black bars —so the male mandrill of Africa appears to have acquired his deeply furrowed and gaudily coloured face from having been thus rendered attractive to the female No doubt it is to us a most grotesque notion that the posterior end of the body should be colour d for the sake of ornament even more brilliantly than the face but this is not more strange than that the tails of many birds should l e c n

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aims before the female and the elaborate manner in which this i performed by male birds and other animals is the strongest argument in favour of the belief that the females admire or are excited by the ornaments and colours displayed before them There is however a striking parallelism between mammals and birds in all their secondary sexual characters namely in their weapons for fighting with rival males in their ornamental appendages and in their colours In both classes when the male I ff

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masculated at an early period loses them In both classes the change of colour is sometimes seasonal and the tints of the naked parts sometimes become more vivid during the act of courtship In both classes the male is almost always more vividly or strongly coloured than the female and is ornamented with larger crests of hair or feathers or other such appendages In a few exceptional cases the female in both classes is more highly ornamented than the male With many mammals, and at least in the case of one bird the male is more odoriferous than the female In both classes the voice of the male is more powerful than that of the female Considering this parallelism there can be little doubt that the same cause whatever it may be has acted on mammals and birds and the result, as far as ornamental characters are concerned may be attributed as it appears to me to the long continued preference of the individuals of one sex for certain individuals of the opposite sex combined with their uccess in leaving a larger number of offspring to inherit their superior attractions

Equal transmission of ornamental characters to both sexes —With many birds ornaments, which analogy leads us to believe were primarily acquired by the males have been transmitted equally or almost equally to both sexes and we may now enquire how far this view applies to mammals With a considerable number of species especially of the smaller kinds both sexes have been coloured independently of sexual selection for the sake of protection but not as far as I can judge in so many cases nor in so st il

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art i so complete as the resemblance He I are on her form is a familiar instance of concealment through colour yet this principle partly fails in a closely allied species the rabbit for when running to its burrow it is made conspicuous to the sportsman and no doubt to all beasts of prey by its upturned white tail No one doubts that the quadrupeds inhabiting snow clad regions have been rendered white to protect them from their enemies or to favour their stealing on their prey In regions where snow never lies for long a white coat would be injurious consequently species of this colour are extremely rare in the hotter parts of the world It de-

33 *Essays and Observations* by J Hunt edited by O 1861 p 194
34 Sir S Bak *The Nile Tributaries of Abyssinia* 1867
35 *F b z beth cu* Audubon and Bachman, *The Quadrupeds of N th America* 1846 p 109

serves notice that man quadrupeds nhab ting naderately cold regions, alth h th do n t assume hite wint dress, becom pal r d this season and thus ppare tl is the direct result of th conditi s to wh h th have long bee exposed Pallas[36] tates th t in Siberia chang of tl nat re occurs with tl e wolf, t species of Mu t la, tl e domestic horse, the *Eq us hem us* the d m t c cow t species of antel pes, th musk-dee th roe, elk, and reindeer Th roe f in tance has red summer and greyish white wi t coat and the latt ma perhaps serv as protectio to th animal whilst wand ri g through the leafless thi k ts, spri kled w tl snow and hoar frost. If the abo e-named ani mals ere grad ally t ext nd tl rang to regions perpetually co red w th sn w tl ei

[illegible]

brown piebald rabb ts in large walled o chard and he had t the sam tim some similarl coloured cats hi house. S ch cats, as I have often noticed, are re con p cuou during da b t as th used to l w tch during the dusk t th m th I tl b rrows, the rabb ts pparentl did n t di tingu sh them from thei parti-col red brethren. Th result was that, thin hteen mo ths, ry one of these part -colo red rabb ts was d stro ed and there was id nce that this was effected b th cats. Colo seems to be ad anta eous t an th animal th kunk, in manner of which w ha had man instances in ther classes. N animal will voluntaril attack one of these creat res eco t of th dreadful odour which t mits wl rrit ted b t during th du k t w uld not asil be recognized and might be ttacked l bea t of prey Hence t is, as Mr B lt beli es,[37] that the skunk is pro ded witl great wh t bushy tail, which serves as con p us arning.

Altho gh w must admit that man quad rupeds ha rece ed their prese t tint ther as protection, as an aid procuring pre yet with host of spec es, th colours are far too conspicuo and too ingularl arranged to allow us to s ppose that tl serv f r these purposes. We ma take as an illustration cer tain antel pes wh n we see the square wl ite patch on the throat, the white marks on the f tlocks, and th round black pots on tl ars, all m re d t nct n tl e mal of the *I rtax picta*, than n the f male —wl n w see that th colours are more i nd that the narrow wh t l es n th flank and th broad wl t bar n the sl ulde are m re dist nct n the male *Oreas derby us* than n tl e f male —wh n w see similar d ff re ce between tl e sexes of th curi d -ornam nted *Tra l phus scriptus* (fig 0) —w can t bel th t diff rences of thi kind are of an ser ce to th se in th ir dail habits of life. It seem a much m re probabl co clusi n that the ari u marks w re first acq ired l y tl e males and tl ir colo rs i t nsified thro gh sexual select n, and then partiall transf rred to th f males. If tl is i w be admitted, tl re can be littl doubt that tl equall singular colo rs and marks of many otl ant l pes, tl o gh commo to both se es, h e been gained and transm tted in a l k mann Both se es, f in tance f the koodoo (*trepsi eros kud*) (fig 64) ha narrow wh t t cal li es n th ir hind flanks, and an l g t angular whit mark th f rel ads. B th se n tl ge u Damalis are y oddly colo red in *D* g th back and neck are purplish red

[illegible]

larg bl g wl t ma k, narrowly-edged w th black, co rs th face up to th (fig 71) th re are three wl t tripes n th f reh ad and th ear are marked w th whit The f wns of thi peci are of unif rm pale llow sh brown. I *Damalis alb frons* th col rin f th l ad diff rs from that n th last pecies a si gl whit tripe replacing the three tripes, nd in th ars being almost h ll white.[38] Aft r ha in studied t th best of my ability tl sexual diff rences of ani mals belo ging to all classes, I cannot I th conclu n th t th curi usl arranged col urs f many ant l pes, th h common to both se es, are th result of se ual select on primarily pplied t tl male.

Th sam co clusi m pe hap be tended to th tig on of th most beautiful

[36] Nova specie Quadruped m Glir m ordine 1778, p. What I ha e called the roe is the *C preolus sibiricus subecaudatus* of I allas.

[37] *The Naturalist in Nicaragua*, p. 249

[38] See the fine plate in A. Smith *Zoology of South Africa*, nd D Gray *Glean g from the Menagerie of Knowsley*



FIG 70 *T gel phu criptu* male (from the *Knowsley Menagerie*)

animals in the world the sexes of which cannot be distinguished by colour even by the dealers in wild beasts Mr Wallace believes[39] that the striped coat of the tiger so assimilates with the vertical stems of the bamboo as to assist greatly in concealing him from his approaching prey But this view does not appear to me satisfactory We have some slight evidence that his beauty may be due to sexual selection for in two pecies of Felis the analogous marks and colours are rather brighter in the male than in the female The zebra is conspicuously striped and stripes cannot afford any protection in the open plains of South Africa Burchell[40] in describing a herd says their sleek ribs glistened in the sun and the brightness and regularity of their striped coats presented a picture of extraordinary beauty in which probably they are not surpassed by any other quadruped But as throughout the whole group of the Equidæ the sexes are identical in colour we have here no evidence of sexual

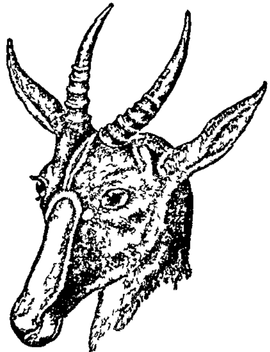


FIG 71 *D m l pyg ga*, male (from the *Knowsley Menagerie*)

Westminster Review July 1 1867 p 5
[40] *Tr v ls n S th Africa* 1824 vol ii. p 315

xtend th sam v ew to the oyal tig r and bea tiful zebra.

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y g ar mark d w th l ngi ud and th s diff from all tl x t g ad lt spe m tl se t g p W tl m y ki d f dee th y g m ked w tl l gant l te pots, f hi h tl p re t h b t n t t ac A grad ted n can be f ll wed f m th n dee b tl sex f wl cl at all ages and d n g ll aso s b autif lly potted (th mal b g tl m t gly col ed t y pecı ın wh l n th t

d g th mm wh n tl g l co th co t is l ght tl an d n g tl w t wh th ral l is d k and the l

cous is eddi l b wn b t qu t disappe r dun g th inte whe th co t b w I both th se pec th y g ar potted In th V d th y u g l k w se potted

ges and seasons A till more ancient prog ni tor pr b bly som wl t resembled th *Hy m s l us aq t c s*—f r tl s an mal is potted an l the lo l ss m l s l e la ge exserted c m t tl f l i l so e f w tru deer t ll r ta n rud nt H n scl s lso ff s se f f m l nk ng o to cer pac m ly tl o gl t to be q t d t t t.

A d ffi ulty l r rises If we admit tl t col l pot d tripes were fr t ac ju d as rna ts, l w com t th t so m v x t ng l r tl d sce d ts f an b ginally potted animal and all tl pe f p gs a l t t tl e descendants f an abo gi ally tr j ed a m l l a e l t n tl r ad lt t te tl r f rme nam nts I cann t t fact ly w r tl ju t n W m y feel alm t tl t th pot an l tr pe dis ppeared t r m t nty in tl pr g to f x t g peci so th t tl y we e t ll t ed by th y u g nd ow g to th l w f l ritance t corre po d g g s, w re t nsm tted to th y g f all ucceed g g n t n It m y h e been a great ad ntag to th l n a d p ma, fr t tl e pen nat f th ll ts to l e l t tl r t pe d to h bee tl r nd ed l ss consp cu to tl p y and f tl e cee e n ti by wh h tl s nd was gai ed oc ed tl l te n l f th y g wo ld l tai ed tl r t pes as n w tl case As t d p gs, d tap rs, F tz Müll r l as t l to m tl t these anim l by tl e

hi h are alw y th m m n mb g y n bl n d t n t From tl con d t tl b t y m ll t p to th compl t abse ce f spots tl ad lts t ll seasons d lastly to th bsen t ll ages and seasons as occurs w th rtai pe ci s. F m th xiste f this perfect se s, and m pecially f m th f wns f so man peci b g potted may co cl d th t tl now l g m mb rs f th dee family ar th d sce dants f som n t pe ie hi h, l k th axis dee was potted t all

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b th tru plan t b t t the tr ge th t tl y g h ld t h e b thus p o- tected nd t ll m re so that th ad lts f som pec ho ld ha ret d ther p ts, th part lly compl tely d n g part f th year W know th t wl n th d me t ass a and becom edd h b wn, g y black, th trip n th l lde and e n n th p f q tly disappear though we cann t pla th cause V y f w h se cept dun-c l ed k nd h e tripes n any p rt f th ir bod y t w h good ason

D Gray *Gle g f m the M nagerie f Knowsley* p 64 M Blyth, peak g (*Land nd Water* 1869 p 42) of th h g-dee f C yl n, y t is mo b ghtly potted th hit tha th comm h g deer t th seaso he t ts h rns.

Falco nd C tl y *P oc Geolog Soc* 1843 nd Falco er *Pal Memoi* l. i., p 196



FIG 70 *Tr g laph s scriptus* male (from the *K ow ley Menageri*)

animals in the world the sexes of which cannot be distinguished by colour even by the dealers in wild beasts Mr Wallace believes[39] that the striped coat of the tiger so assimilates with the vertical stems of the bamboo as to assist greatly in concealing him from his approaching prey But this view does not appear to me satisfactory We have some slight evidence that his beauty may be due to sexual selection for in two pecies of Felis the analogous marks and colours are rather brighter in the male than in the female The zebra is conspicuously striped and stripes cannot afford any protection in the open plains of South Africa Burchell[40] in describing a herd says their sleek ribs glistened in the sun and the brightness and regularity of their striped coats presented a picture of extraordinary beauty in which probably they are not surpassed by any other quadruped But as throughout the whole group of the Equidæ the sexes are identical in colour we have here no evidence of sexual selection Nevertheless he who attribute the white and dark vertical stripes on the flanks of various antelopes to this process will probably



FIG 71 *D mal pyg ga*, male (from the *K u ley M geri*)

[39] *Westminster Review* July 1 1867 p 5
Travels in S th Af ic 1824 v l ii p 315



F G. 5 Head of *Atele marginatus*.



FIG. 6 H ad of *C bus macrorus*.

we have additional vid ce of th acti n of sexual selection th gre t iz and trength of th males, and in the gre t r de lopm nt of their canin teeth n comparison w th th females.

A f w instances ll suffice of th trange mann n wh h both se es of some species are col red and of th be uty of oth rs. The face of th *Cercop thecus pet rus* (fig 77) is black, th whi kers and beard be g wh te, w th a d fined ro nd whit spot on the nose co red w th short whit hair wh h gi s to th animal an almost l d crous a pect The *Sem opithecus fro tatus* lik w se has blackish face w th a lo g black beard, and a la ge nak d pot on th f re h ad of a bluish whit col Th face f *Macacus lasiotus* is dirty fl h-co l ured with a d fined red pot ach cheek. Th ppearance f *Cercocebus th ps* is grotesq e with its black face white whiskers and collar hestnut h ad and a large naked wh t spot o ach lid In ry many pe ci s, th beard whisk rs, and cre ts f hair round th face re of a diff re t colou from th e re t of th h ad and wh n d f ferent, are al y of a l ght tint,[a] be g ft n p re whit som tim bright y llow reddish Th wh l face of th So th Am rican *Brachyurus calvus* is of gl wing scarlet hu b t th is col does n t ppear til the animal is n arl ma ture.[b] Th naked kin f the face diff rs w nd rf ll n col ur in th ari u species. It is oft brown fl h-colour w th

Fig. 77 *Cercopithecus petaurista* (from Brehm).

[a] I observed this f ct in th Zoological G rd nd m y cases ma be see in th coloured plates in Geoffro St Hilaire and F C *Histoire Nat. de M mm fères* tom. i., 1824

[b] B tes, *The Natu alist on the Amazons*, 1863, ol ii., p. 310.

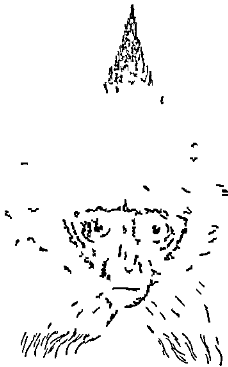


FIG 7 He d f *Semnopitl ec rubic d s* Th nd the f ll g figu es (from I r f ssor G r is) re g n to h w the odd rr ge m nt and dev lopm nt of th hai on the h d

tion made by Mr Sclater well illustrates our ignorance of the laws which regulate the appearance and disappearance of stripes the species of Asinus which inhabit the A iatic *continent are destitute of stripes*, not having even the cross shoulder stripe whilst tho e *which inhabit Africa* are conspicuously striped with the partial exception of *A taniopus* which has only the cross shoulder stripe and generally some faint bars on the legs and this species inhabits the almost intermediate region of Upper Egypt and Abyssinia [4]

Quadrumana —Before we conclude it will be well to add a few remarks on the ornaments of monkeys In most of the pecies the sexes resemble each other in colour but in some as we have seen the males differ from the females e pecially in the colour of the naked parts of the skin in the development of the beard whiskers and mane Many pecies are coloure l either in so extraordinary or so beaut iful a manner and are furnished with such curious and elegant crests of hair that we can hardly avoid looking at these characters as having been gained for the sake of ornament. The accompanying figures (figs 7 to 16) serve to shew the arrangement of the hair on

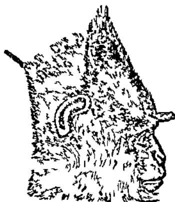


FIG 8 He d f *S m p tl comatus*



FIG 74 He d of *C b cap ci us*

to believe that the aboriginal horse was striped on the legs and spine and probably on the shoulders [43] Hence the d sappearance of the spots and stripes in our adult existing deer pigs and tapirs may be due to a change in the general colour of their coats but whether this

cause it is impossible to decide An observa

without the aid of selection an l it is incon cei able that they can be of use in any or

to both se es With many of the Q adrumana,

[43] *The Variatio f A mal nd Plant nder Dome tication*, 1868 v l. i pp 61-64.

[44] *P oc Zool Soc* 1862, p 164 See also Dr Hart mann *Ann. d. Landw* Dd l s. 222

rangeme t of the crests and tufts f hai n their heads, f rce th con cti n m m nd tat these charact ha e been acq red through sexual selecti n exclusi ly as rna ments.

mmary —Tl law f battle f tl pos ses o of tl f mal ppearst pre ailthro gh out th wh l gre t lass f mammals. Most re t ze

f ... I se ec

for lif b t certain u generall th m l be g cces f l con

the po rf l od rs m tted b tl mal during th breeding season the od rif rous glands ha m bee acq ired thro gl se l select Wl th th sam w can be

ll conseq tl h been tran m tted t the sam sex. Vari us cre ts, tufts, and man tles f hair h h are th confi ed t th male are m re d loped in thi sex than in th f m le seem most ases t be m rel ornamental, th h th som t m serv as d f nce gainst ri al males Th re n so t uspect th t th b an l h rns f ta s, and th le ant h rns f certain ant lopes, tho gh prope l serving as w pons of off nce d f ce ha been partl modified f rnam t

Wh th mal diff rs in colour from tl f mal h g rall xhib ts dark and m re tro l -co trasted tints. W d n t this class meet w th tl pl nd d red bl ll w and gree tints, so comm n witl mal b rd and many th animals. Th naked parts, h we er of ce tain Quadrumana nu t be cepted for uch parts, often oddly situated are brill antl col ured n some peci s. Tl col urs f tl mal n th ase m y be l to si pl an t w tl ut tl e aid of sel c ti n B t wl tl col urs are di sif ed n l tro gly pron ced wh they are n t de l ped u t l ar m t rity and wl en tl v are l t aft emasc lati n we can hardl l tl co l n th t tl y h bee ac q red througl sex al select on f r th sake f rname t and ha been transm tted l si l r almost x l usi l to tl sa se Wl n botl se ar colo red n tl sar man r and tl colo are con. or curi l arrange l w th t be g f the l ast app re t se as protect n, an l espec ll wl th ar assoc ted w th ari tl orn t l i pe l es, w are led b anal gy t h

p cu ar l d rsified colou s, w u co f l l r comm n to botl se es, re gro se

t, w ll be f nd to l ld good l w ook back t tl ari case gi n in this and th last l pt

Th law f tl eq l transmis n of l r act rs to both se s, as far as col ur and otl e ornam nt are co cerned has pre led far m re ext n l w th mammals than w th l rd l t w po s, l as h rns and t ks,

males t n mi f ll ki ds, th w pon

ance whi h l as pre ailed Finall w th q ad ruped th co test b tween th d d l f th sam se h th peacef l bloody l as, w th th rare t cept s, been confined t th mal so th t th latt ha been mod fied thro gh se al selecti far m re com m nl than th f mal s, th f fight g w th each th f lluring th opposit sex.

parts perfectly white and often as black as that of the most sooty negro In the Brachyurus the scarlet tint is l ... that of ... It is ... in any ... and in several species it is blue passing into violet or grey In all the species known to Mr Bartlett in which the adults of both sexes have strongly coloured faces the colours are dull or absent during early youth This likewise holds good with the mandrill and Rhesus in which the face and the posterior parts of the body are brilliantly coloured in one sex alone In these latter cases we have reason to believe that the colours were acquired through sexual selection and we are naturally led to extend the same view to the foregoing species though both sexes when adult have their faces coloured in the same manner

Although many kinds of monkeys are far from beautiful according to our taste other species are universally admired for their elegant appearance and bright colours The *Semnopithecus nemæus* though peculiarly coloured is described as extremely pretty the orange tinted face is surrounded by long whiskers of glossy whiteness with a line of chestnut red over the eyebrows the fur on the back is of a delicate grey with a square patch on the loins the tail and the fore arms being of a pure white a gorget of chestnut surmounts the chest the thighs are black with the legs chestnut red I will mention only two other monkeys for their beauty and I have selected these as presenting slight sexual differences in colour which renders it in some degree probable that both sexes owe their elegant appearance to sexual selection In the moustache monkey (*Cercopithecus cephus*) the general colour of the fur is mottled greenish with the throat white in the male the end of the tail is chestnut but the face is the most ornamented part the skin being chiefly bluish grey shading into a blackish tint beneath the eyes with the upper lip of a delicate blue clothed on the lower edge with a thin black moustache the whiskers are orange coloured with the upper part black forming a band which extends backwards to the ears, the latter being clothed with whitish hairs. In the Zoological Society's Gardens I have often overheard visitors admiring the beauty of another monkey deservedly called *Cercopithecus*



FIG 78 *C r op th d a* (from Brehm)

diana (fig 78) the general colour of the fur is grey the chest and inner surface of the fore legs are white a large triangular defined space on the hinder part of the back is rich chestnut in the male the inner sides of the thighs and the abdomen are delicate fawn-coloured and the top of the head is black the face and ears are intensely black contrasting finely with a white transverse crest over the eyebrows and a long white peaked beard of which the basal portion is black

In these and many other monkeys the beauty and singular arrangement of their colours and still more the diversified and elegant

I ha se n mo t f th b m k y tl Zool g cal Soc ty s G rd Th descr pt f the *S mnopithecu nemæ* is t k f m M W C M rt *N t l Hist y f M mmal* 1841 p 460 b pp 47 5 3

or being fully d k ped within y ar n the Soudan, but not until three y ars in Egypt. The eyes of the negro are t first blu and the hair chestnut-brown r th r than black be ng curled onl t the nds. Th ch ldren of the Australians immediat ly aft r b rtl are l- brownish-brown, and becom d k t lat e Those of the Guaranys f Paragua are whitish-yellow b t the acquire in tl e course d f w weeks the y Lowish brown tint of their parents. S milar observ tions ha been made in othe parts of Am rica.

The pecified th f reg ing diff rences be tween the mal and f male se in mankind be cause th are curiously lik those of th Quadrumana. With tl ese animals th f male is mature t an arli than tl ma t that this is certainl th case in C bus a a The males of most pecies are larg and stronger than the f males, f wh ch fact th gorilla affords w ll-know instance E n in so trifling charact as th great prominence of th superciliary rid th males of certain monke s diff from th f ma s, and agree in this respect w th mankind In th gorilla and certain th monkeys, th cranium of the adult male present t o gl marked sagittal crest, which is abse t in t f male and Eck f und t ace of similar diff rence between th tw se es in th Australians. With mo key wh th re is any diff rence in the voice that of th mal is th m re pow ful. W ha seen that certain mal m nkeys ha well-d loped beard which is quit de ficient, much less d loped th f mal N instance is kn wn of the beard whiskers, moustache bein large in th f male than in th male monke E n in th colou of the reddish. I have repe tedly observed this fact in En land b t two gentlemen h e lately written t me sa i g th t th s f rm an ception to tle en ac cou ts colour s des of th pec harity (o e of th m na been accused of d ing h s beard) n l had been tl us led to observ oth r m n and were co t ceed that tl ceptio s w re v ry rare D Hooke tt nded to thi l ttle point f me in Russia. nd f nd no excepti n to tl e rule In Calcutta, M J Scott, of th Botani Gar d ns, was so kind as t observ th man races of m n to be seen tl re as well as in som other parts f I dia, nam l two races f S kl m th Bhoteas, H ndoos, B rmese and Ch nese th m t of which aces ha e ry l ttl hai n the face and h l w y f und that wh n tl ere was any diff re ce in ol u between th hair f the h ad and the beard th latte was ariably li ht N w with m nkeys, as has already been tated tl beard freq ntl diff rs strik ngly in colour from the hair of tl h ad and in such cases t is alw f a l ght h e being oft n pure whit som times llo or redd h.

In regard t th g ral airi ess of the body tl w m n in all aces are less hairy than th m n and in som f w Quadru nana the und side of th body f the f male l ss hairy than that of th mal u Lastly male m nke s, lik m n, re bold and fi rcer than th f males. Th y l ad th troop, and wh n th re is dang com t tl fro t. W th see how close is th parallel sm between the se u l diff rences of man and th Q adrumana. W tl som f w pecies, l w w th certain baboons, th rang and th gorilla, th re a consid rably great diff rence betwee th se es, as in the size of th canine teetl in the d lopm t and colour f th hair and espe

almost alw of light t nt, being oft n

Pruner Bey egro nf ts as quoted by V t, *Lectures on M n*, E g tra slat., 1864 p. 1 9 f further facts negro nf s, as quoted from W n terbottom nd Camper see La rence *Lect on Physiology &* 1 22, p. 451 F the nf ts of the Guara s, see R gger ethier *de* S see so Godron, *De l'Espec* tom. u. 1859 p 253 For he Australians, W tz, *Introd ct on to A thropology* E g transat 1863, p. 99

Re gger ethier *de* 1830, s. 49

As *Macacus cynomolgus* (Desmarest, *M m malogie* p. 65), nd *Hylobate gus* (Geoffroy St Hilaire and F C *Histoire Nat. de M mmi feres*, 1 24 m i., p. 2)

Anthropological Review Oct., 1868, p. 353.

M Blyth forms me that h has nly see ne instance of the beard, hiskers, &c., in monk y becomi g h t th ld ag as so ommo ly the case th us. Th s, ho ever occurred aged *Macacus cynomolgus* k pt co finement whose mou taches were rema kably lo g nd human-like. Altog ther this ld mo key prese ted ludicrous resemblance t of the reigning monarchs of Europe after hom he was uni ersally nick amed. I certain races of ma th hair the head hardly ever becomes grey thus M D Forbes has never as he nforms me seen insta ce with the Aymaras and Quechuas of South America.

This is the case with th females of several species of Hylobates see Geoffroy St Hilaire and F C vier *Hist. Nat. de M mm.*, tom. See also, n H lar *Penny Cyclopedia*, ol. u., pp. 149, 150.

Part Three

Sexual Selection in Relation to Man and Conclusion

CHAPTER XIX

SECONDARY SEXUAL CHARACTERS OF MAN

WITH mankind the differences between the sexes are greater than in most of the Quadrumana but not so great as in some for instance the mandrill Man on an average is considerably taller heavier and stronger than woman with squarer shoulders and more plainly pronounced muscles Owing to the relation which exists between muscular development and the projection of the brow the superciliary ridge is generally more marked in man than in woman His body and e pecially his face is more hairy and his voice has a different and more powerful tone In certain races the women are said to differ slightly in tint from the men For instance Schweinfurth in peaking of a negress belonging to the Monbuttoos who inhabit the interior of Africa a few degrees north of the equator ays Like all her race she had a skin several shades lighter than her hu band s being something of the colour of half roasted coffee [2] *As the women labour in the fields and are quite unclothed it is not likely that they differ in colour from the men owing to less exposure to the weather European women are perhaps the brighter coloured of the two sexes as may be een when both have been equally expose l*

Man is more courageous pugnacious and energetic than wo an an l has a more in en tive genius His brain is al solut ly l rger but whether or n t proportionately to l is larger body has

In woman

base of the skull ma

body rounder in parts more p omin ent an l

her pelvis is broader than in man [4] but this latter character may perhaps be considered rather as a primary than a secondary exual character She comes to maturity at an earlier age than man

As with animals of all classes o with man the distinctive characters of the male ex are not fully developed until he i nearly mature an l if emasculate l they never appear The beard for instance is a econdary exual char acter an l male children are beardless though t n a l re they l a e abun lant l air on the

The female however ultimately assumes tain listinct e charact r and in the forma tion of her skull i ai l to be interme liate be tween the chil l and the man Ag in as the l th l ough l tinct pecies

tan ed that race lifferc ce can t e in the infantile skull [6] I regard to colour the ne born negro child i red li h nut l ro n wl ich soon becomes slaty gr y the l l ck col

chaaffhau n tra l t o *t ll opol gi l Rev* Oct 1868 pp 419 420 4 7
The Heart f Afric Engl h t nsl 1873 ol p 544

w th cl by W l k
l k d W l l *b l* pp 3 355 V gt *L t* o M l g tra l t p 81
chaaffhausen *Anth pol g Rev ew* *Ind* p 429

sooner full d loped within year in the woman, b t not until three y ars in Egypt. The eyes of the negro are at first bl and th air chestn t-brown rath than black, be g curled on at the nds. The hildren of th A... ans immediat l after birth are yellowish-brown, and become dark t a lat a. Those of the Guaranys of Paraguay re ... ish-yellow b t they acq ire in the course of few weeks the Lownish-orown tint of their parents. imilar observ tions ha been made in other parts of America.

I have specified the fore oing diff rences between the male and female sex in mankind, because they are curiously l k those of th Quadrumana. W th these animals th f ma ... ure t an arlie than the male at least this is certainl th case in C bus ... The males of most pecies are larg and stronger than the f males, of which fact th gorilla a ords w ll-known instance E n in ... agree in this respect with mankind In th gorilla and certain othe monkeys, the cranium of the adult male presents trong l marked sagittal crest, which i abs t in t f male and Ecke found trace f a similar difference be ween the t sexes in th A tralians. With monkeys wh n there is any difference in the voice that of the male is th more pow ful. W have see that certain male monkeys have well-d loped beard, which is quit deficient, or much less d loped in the f male N instance i known of the beard whiskers, or moustache being large in th f male than in the male monke Eve in th colour of th beard there is curious parallelism between man and the Quadrumana f w th man when the beard differs in colo from th hair of th head, as is commonl th case t is, I bel e, almost alw of lighte ti t, being often reddish. I ha e repeatedly observed this fact in England b t two gentl men hav lately writt n to m sa in th t they form an exception to ... On of these g ntlemen ac- co ts colou sides of hi famil ... of this peculiarity (on of th m ha ing often been accused of d ing h s beard) and had been thu led to observe ther m n, and were con nced that t xceptio s w re ry rare D Hook att nded to this l ttle point f me in Russia and f nd no e ception to the rule In Calcutta, M J Scott, of th Botanic Gar d ns, was so kind as to observe the man races of men be see th re as well as in som other parts of I ha, nam l two races of Sikl m, the Bhoteas, Hindoos, B rmese and Chinese most of which races ha e ery little hair on the face and h alw f und that when th re was any diff rence in colou between th hair of th head and the beard the latt was n ariably l ght N w with m nkeys, as has already been tated, th beard frequentl diff rs strikingly in colour from the hair of th h ad and in such cases t is alw of a l ght hu ben often pure white som tim low or redd sh.

In regard to th g neral airness of th bod the w men in all races are less hairy than th men and in som f w Quadrumana the und sid of th bod of the f male is less hairy than that of th male[1] Lastly male monk s, like m n, are bold and fi rce than th f males. They lead th troop, and wh n th re is dan come to th front. W th s see how close is the parallelism between th se u l diff rences of man and th Quadrumana. W th som f w pecies, h w as w th certain baboons, th orang and th gorilla, there a consid rabl great diff rence between th sexes, as in the size of th canine teeth in th d lopme t and colour of th hair and espe

Pruner Bey on negro infants as quoted by V gt, Lectures on M n, Eng tra slat., 1864 p. 1 9 f further facts on negro nfan s, as quoted from Winterbottom and Camper see La rence Lect on P ysiology, &c 1 ... p. 451 For the nfants of the Guaranys, see Rengger ... thiere d s. S See ... De l'Es ec ... 1859 p ... For the Australians, W z, Introd ction to A thropology Eng transl., 1863, p 99

Rengger ... ugethiere d 1830, s. 49.

... Macacus cynomolgus (Desmarest, M mmalogie p 65), and in Hylobates ... (Geoffroy St Hilaire and F Cuvier Histoire Nat. des M mmifères, t. II tom. i., p. 2)

Anthropological Review Oct., 1868, p. 353.

ever as he nforms me seen an instance with the Aymaras and Quechuas of South America.

[1] This is the case with the females of several species of Hylobates see Geoffroy St Hilaire and F Cuvier Hist. Nat. des M mm., tom. See also, H lar Penny Cyclopedia, vol ii., pp. 149, 150.

cially in the colour of the naked parts of the skin than in mankind

All the secondary sexual characters of man are highly variable even within the limits of the same race and they differ much in the several races These two rules hold good generally throughout the animal kingdom In the excellent observations made on board the *Novara* [12] the male Australians were found to exceed the females by only 65 millim in height whilst with the Javans the average excess was 218 millim so that in this latter race the difference in height between the sexes is more than thrice as great as with the Australians Numerous measurements were carefully made of the stature the circumference of the neck and chest the length of the back bone and of the arms in various races and nearly all these measurements shew that the males differ much more from one another than do the females This fact indicates that as far as these charac ters are ... ale which has ... several races ... ock

The development of the beard and the hairiness of the body differ remarkably in the men of distinct races and even in different tribes or families of the same race We Europeans see this amongst ourselves In the Island of St Kilda according to Martin [13] the men do not acquire beards until the age of thirty or upwards and even then the beards are very thin On the Europæo Asiatic continent beards prevail until we pass beyond India though with the natives of Ceylon they are often absent as was noticed in ancient times by Diodorus Eastward of India beards disappear as with the Siamese Malays Kalmucks Chinese and Japanese nevertheless the Ainos [15] who inhabit the northernmost islands of the Japan Archipelago are the hairiest men in the world With negroes the beard is scanty or wanting and they rarely have whiskers in both sexes the body is frequently almost destitute of fine down [16] On the other hand the Papuans of the Malay Archipelago who are nearly as black as negroes possess well-developed beards [17] In the Pacific Ocean the inhabitants of the Fiji Archipelago have large bushy beards whilst those of the not distant archipelagoes of Tonga and Samoa are beardless but these men belong to distinct races In the Ellice group all the inhabitants belong to the same race yet on one island alone namely Nunemaya the men have splendid beards whilst on the other islands they have as a rule a dozen straggling hairs for a beard [18]

... tinent ... in al most all the tribes a few short hairs are apt to appear on the face especially in old age With the tribes of North America Catlin estimates that eighteen out of twenty men are completely destitute by nature of a beard but occasionally there may be seen a man who has neglected to pluck out th ...

... informed by Mr D Forbes who particularly attended to this point that the Aymaras and Quechuas of the Cordillera are remarkably hairless yet in old age a few straggling hairs occasionally appear on the chin The men of these two tribes have very little hair on the various parts of the body where hair grows abundantly in Europeans and the women have none on the corresponding parts The hair on the head however attains an extraordinary length in both ...

... body the sexes of the American aborigines do not differ so much from each other as in most other races This fact is analogous with what occurs with some closely allied monkeys thus the sexes of the chimpanzee are not

[12] The results ... deduced by Dr Weisbach ... measurements made by Dr K Scherzer ... Schwarz see *Reise der Novara: Anthropolog Theil* 1867 s 216 231 234 236 239 269

[13] *Voyage to St Kilda* (3rd edit 1753) p 37

[14] J E Tennent *Ceylon* ... 1859 p 107

[15] Quatrefages ... *Revue des Cours Scientifiques* Aug 29 1868 p 630 Vogt *Lectures* ... *Man* Eng translat p 12 ...

[16] On the beards of negroes Vogt *Lect* ... p 127 Waitz *Introduct to Anthropology* Eng transl 1863 vol i p 96 It is remarkable that in the United States (... *Investigations in Military and Anthropological Statistics of American Soldiers* 1869 p 569) the ...

[17] Wallace *The Malay Archipelago* 1869 p ...

[18] Dr J Barnard Davis ... *Anthropological Review* ... 1870 ...

is different as those of the orang gorilla.[a]

In the previous chapters we ha e seen that with mammals, birds, fishes, insects, & ., many characters, which there is rv reason to believe were primaril gained through se ual selection b ne sex, ha been transf red to the other As thi same form f tran missi n has apparentl pre ailed m ch with mankind t wil sa e useless repetition if w d scuss th origin of charact rs peculiar t th mal sex together with certain th characters common to both sexes.

H orum mulier teterrima bell causa. m

Hearne[a] says— It has been th custom amon these people f th m n to wrestle for an woman t whom th re t tached and, of course th tronge t part al carries ff th prize A w ak man unless he be ood hunt and w ll-belo ed is seldom permitted to keep wif that stronge man thinks worth his notice This custom prevails througho t all th tribes, and causes a great spirit of mulatio am th th, who are po all occas ns, from their hild hood, trvin th ir trength and kill in wrestling. With the Guanas of So th Am rica, Azara tates that th men rarely marry till t ent ars ld more as bef re that ag they cannot co que ther ri als.

Other similar facts could be gi n but n d had no nd nce n this h ad w might feel almost sure from th analogy f th high Quadrumana,[b] that th law of battl had pre ailed with man d rin th earl tages of his d lopme t Th occasional ppearance at the present da of canin teeth which project abo th th rs, with traces f diast ma or pe space f th reception of th ppo t canines, is in all probabilit case f re rs n to f rmer st t wh n th progen tors of man were pro ided w th these w apons, like so man xist g mal Quadrumana. It was remarked n a f rm hapt r that as man grad uall became rect, and continually used his hands and arms f fight ng w th sticks and tones, as w ll as f r th oth purposes of life h would h e used hi j w and teeth l ss and less. Th j ws, to etl w th th ir muscles, w ld tl n ha e been reduced through disuse as would tl e teetl thro gh the not well und r stoo les f correlat n and eco om of gro wh siz tw mankind ated Th case is alm t parallel w th that of many ts, n which th cani e teeth l ha of th diff re ce be ween in th orang and gorilla tand in lose relation w th th d lopm t of the immense ani e teetl in th males, w ma inf r that the reduction of th j w and teeth in th arl male pro nitors of man must ha led to a most striking and fa ourabl change in his ppearance

Th re can be little doubt that the gre t r size and tre gth of man, in comparison w th woman t geth w th his broad r sh ulders, more d loped muscles, rugged o tlin of bod his gre t courag and p gnac ty are all d in ch f part to inh ritance from hi half human mal ancest rs. These characters w ld h w ha e been preserved o n ti n tl long ages f man sav w uld h nsured th l ing a m re nu m rou pro en than th less f red brethren. It is n t probabl th t th gre t tre gth of man was primaril acquired thro gh th inh rited ffects f his ha ing w ked hard than w man fo hi own subsistence and that of hi famil f th w m n in all barbarous has lo g ceased th ther hand th m n, as a g ral rul h to w k hard than th w m n f th j int subsistence, and thus th ir greate trength will ha been kept up.

[a] ... North Am rica ... America see Azara, *Voyages, &* tom. ii., p. 94
[b] On the fighting of the male gorillas, see Dr Sa age in *Boston Journal of Nat ral History* ol. v 154 p. 423. On *Presbytis entellus*, see the *Indian Field*, 1859 p. 146.

Difference in the Mental Powers of the two Sexes.—With respect to differences of this nature between man and woman, it is probable that sexual selection has played a highly important part. I am aware that some writers doubt whether there is any such inherent difference; but this is at least probable from the analogy of the lower animals which present other secondary sexual characters. No one disputes that the bull differs in disposition from the cow, the wild boar from the sow, the stallion from the mare, and, as is well known to the keepers of menageries, the males of the larger apes from the females. Woman *seems to differ* from man in mental disposition, chiefly in her greater tenderness and less selfishness; and this

lers. Woman, owing to her maternal instincts, displays these qualities towards her infants in an eminent degree; therefore it is likely that she would often extend them towards her fellow-creatures. Man is the rival of other men; he delights in competition, and this leads to ambition which passes too easily into selfishness. These latter qualities seem to be his natural and unfortunate birthright. It is generally *admitted that with woman the powers of in*tuition, of rapid perception, and perhaps of imitation, are more strongly marked than in man; but some, at least, of these faculties are characteristic of the lower races, and therefore of a past and lower state of civilisation.

The chief distinction in the intellectual powers of the two sexes is shown by man's attaining to a higher eminence, in whatever he takes up, than can woman—whether requiring deep thought, reason, or imagination, or merely the use of the senses and hands. If two lists were made of the most eminent men and women in poetry, painting, sculpture, music (inclusive both of composition and performance), history, *science, and philosophy, with half a* dozen names under each subject, the two lists would not bear comparison. We may also infer, from the law of the deviation from averages, so well illustrated by Mr. Galton, in his work on *Hereditary Genius*, that if men are capable of a decided pre-eminence over women in many subjects, the average of mental power in man must be above that of woman.

Amongst the half-human progenitors of man, and amongst savages, there have been struggles between the males during many generations for the possession of the females. But mere bodily strength and size would do little for victory, unless associated with courage, perseverance, and determined energy. With social animals, the young males have to pass through many a contest before they win a female, and the older males have to retain their females by renewed battles. They have, also, in the case of mankind, to defend their females, as well as their young, from enemies of all kinds, and to hunt for their joint subsistence. But to avoid enemies or to attack them with success, to capture wild animals, and to fashion weapons, requires the aid of the higher *mental faculties, namely, observation, reason,* invention, or imagination. These various faculties will thus have been continually put to the test and selected during manhood; they will moreover have been strengthened by use during this same period of life. Consequently in accordance with the principle often alluded to, we might expect that they would at least tend to be transmitted chiefly to the male offspring at the corresponding period of manhood.

Now, when two men are put into competition, or a man with a woman, both possessed of every mental quality in equal perfection, save that one has higher energy, perseverance, and courage, the latter will generally become *more eminent in every pursuit, and will gain* the ascendancy.[24] He may be said to possess genius—for genius has been declared by a great authority to be patience; and patience, in this sense, means unflinching, undaunted perseverance. But this view of genius is perhaps deficient; for without the higher powers of the imagination and reason, no eminent success can be gained in many subjects. These latter faculties, as well as the former, will have been developed in man, partly through sexual selection,—that is, through the contest of rival males, and partly through natural selection,—that is, from success in the general struggle for life; and as in both cases the struggle will have been during maturity, the characters gained will have been transmitted more fully to the male than to the female offspring. It accords in a striking manner with this view of the modification and re-inforcement of many of our mental faculties by sexual selection, that, firstly, they notoriously undergo a considerable change at puberty,[25] and, secondly, that eu

[24] J. Stuart Mill remarks (*The Subjection of Women*, 1869, p. 122), "The things in which man most excels woman are those which require most plodding, and long hammering at single thoughts." What is this but energy and perseverance?

[25] Maudsley, *Mind and Body*, p. 31.

marks remain throughout lif inf ri r in tl ese me qualit es. Thus, man has ult mat l be- ome superior to w man. It is, indeed f rtu ate that the law of th equal transmission of characters to both se es pre ails w th mam mals otherwise t is probabl that man w uld have become as superi in mental end wm nt to woman, as th peacock is in rnam ntal plumage to th pe h n.

It must be born in mind that th t nd ncy n charact rs acq ired b th r sex lat in Le, to be transmitted t the same sex at the same age and of rly acquired haract rs to be transmitted t both se es, are rules which, though general, d not alw hold If th al- ys eld good, we might conclud (b t I h re exceed m proper bound) that th inherited effects of the arly ed cati n f bo and gi ls uld be transmitted equall t both sex so that th prese t inequal ty in mental pow be- tween the sexe w ld not be ffaced by a sim- ilar course of early training n t ha ber caused b thei dissimilar arl training. I ord that w man should reach th sam standard as man, she ght, wh n nearl adult to be trained t rgy and perse rance and to ha he reaso and imaginatio x rcised to the highest point and then sh would prob- abl transmit th se qualities chi fly t her adult daught rs. All w m n how could not be thus raised unless d rin many g n ations those wh celled n th abo robust virtues w re married and prod ced off prin in lar numbers than other w men. As be- fore remarked of bodil trength, alth gh men d t now fight for th ir w es, and this form of selecti n has passed w t during manhood. th g n rall und rg a se re truggle in ord t maintai th msel and their families and this w ll t nd t keep up increase th ir m ntal powers, and as conseq nce the present inequal ty between the se es.[33]

Voice nd Musical P wers —In som species of Quadrumana th re is a gre t diff rence be t een the ad lt se es, in th pow of th ir ice l t of th vocal or gans d ff cord man th for t "arrests that promin nt p thyro d &c. which accompanies th elong ti n f tl e cords. [34] W th re pect to th cause of th difference between tl e sexes, I ha e nothing to add to the remarks n tl e last chap- t on th probabl ffects of tl lo g-contin ed use of th ocal organ l the mal und r th nt ment of lo e rag and j al u y Ac cording t S r Duncan G bb [35] tl vo ce and th f rm of th larynx diff in the d ff rent races of mankind but w th th Tartars, Cl nese &c the oice f tl e mal s said n t to diff so much from that of th female as in most tl aces.

Th capacity and lo for nging or music th gh not a sexual haracter in man, must not h re be passed o e Although th sounds n tted by animal f all kinds serve man purposes, trong case can be mad out, that th ocal rgans were primaril used and per fected in relation t the propagati n f the pecies. Insects and som f w j id rs are the l west animal whi h v l ntarily produce an sound and th is is g rall ffected by th aid of w f ll constru ted trid lating organs, w T[36] se c l

Th sou d produced by nsn al som cases t be mad nly b th mal dur ng th breeding season. All the air-breathing V rt brata, necessaril posses an pparat s f inhaling and xpelling ai with a pipe cap- abl of being closed t n nd Hence wh n th prim al membe of this lass were trong ly excited and th ir muscl lentl contract ed p rposeless sound w uld almost ce taml ha been prod ced and these if th pro ed in an w service hl might readily ha been modified o int nsified by th preserva tion of prope ly ad pted ar tio s. Th low

[33] observatio b V gt bears this subject he says, It is remarkable circumst ce that th difference bet ee th se es, as regards the cra ial ca ty ncreases th the developme t of the race so tha the male European cels m h more the fe- male than th gro the gress. W lcker confirms this stateme t of Huschk from his measurem ts of negro nd Germa kulls. B t V gt adm t Lect on M n, E g translat., 1864 p. 81) that more observati ns are requisit this poi t.

[34] Ow n, *Anatomy f Vertebr te* ol iii, p. 603

[35] *J rnal of the Anthropological Society* April 1869 pp l nd lxvi.

[36] D cudder Notes Stridulation, in *Pro Bosto Soc. f Nat. H st.*, ol. xi., April, 1868.

... are incessantly used during the breeding season and which are often more highly developed in the male than in the fe male The male alone of ... itters a ... of love ... e same ... ery one knows how much birds use their vocal organs as a means of courtship and ome species likewise perform what may be called instrumental music

In the class of mammals with which we are here more particularly concerned the males of almost all the species use their voices during the breeding season much more than at any other time and some are absolutely mute ex cepting at this season With other species both sexes or only the females use their voices as a love-call Considering these facts and that the vocal organs of some quadrupeds are much more largely developed in the male than in the female either permanently or temporarily during the breeding season and considering that in most of the lower classes the sounds produced by the males serve not only to call but to excite or allure the female it is a sur prising fact that we have not as yet any good evidence that these organs are used by male mammals to charm the females The American *Mycetes caraya* perhaps forms an exception as does the *Hylobates agilis* an ape allied to man This gibbon has an extremely loud but musical voice Mr Waterhouse states[30] It appeared to me that in ascending and descending the scale the intervals were always exactly half tones and I am sure that the highest note was the exact octave to the lowest The quality of the notes is very musical and I do not doubt that a good violinist would be able to give a correct idea of the gibbon s composition ex cepting as regards its loudness Mr Water house then gives the notes Professor Owen who is a musician confirms the foregoing statement and remarks though erroneously that this gibbon alone of brute mammals may be said to sing It app ... d ... e ... t from the analogy of other ani mals it is probable that it uses its musical powers more especially during the season of courtship

This gibbon is not the only pecies in the genus which sings for my son Francis Dar win attentively listened in the Zoological Gar dens to *H leuciscus* whilst singing a cadence of three notes in true musical intervals and with a clear musical tone It is a more surprising fact that certain rodents utter musical sounds Singing mice have often been mentioned and exhibited but imposture has commonly been su pected We have however at last a clear account by a well known observer the Rev S Lockwood[3] of the musical powers of an American species the *Hesperomys cognatus* belonging to a genus distinct from that of the English mouse This little animal was kept in confinement and the performance was repeat edly heard In one of the two chief songs the last bar would frequently be prolonged to two or three and she would sometimes change from C sharp and D to C natural and D then warble on these two notes awhile and wind up with a quick chirp on C sharp and D The dis tinctness between the emitones was very marked and easily app ...

... for time yet she would keep to the key of B (two flats) and strictly in a major key Her soft clear voice falls an octave with all the precision possible then at the wind up it rises again into a very quick trill on C sharp and D

A critic has asked how ...

... musical note R ...

... aerial simple vibrations of various periods each of which ... tly ... ed ... vi ... se ... us ...

... high importance of this power to all animals is admitted by every one—must be sensitive to musical notes We have evidence of this capacity even low down in the animal scale thus crustaceans are provided with au ditory hairs of different lengths which have been seen to vibrate when the proper musical notes are struck[3] As stated in a previous

... duction ... p 432

[3] Am nc ... 1871 p 761

[3] Helmholtz Théorie Phys de la Musique 1868 p 187

chapte sim lar bse ati n h b en mad o the hairs f th ant nnæ f gn ts It l as l l h ood b rve s l

music, and th r f d s f as known to th an ts, and is oft n t k n d antage f by the hunt s t th present d

Th ref as f as the n percept n f m ical t co cerned the eems no pe cial diffi lty th ase f m n f n the animal H lmh lt l as pl ed n ph o- l gical prin pl hy cord g e bl and discord d sagree ble t tl l m b t e are l ttl co ce ed w th these as m ic in harm y l t m ent n W m e concerned w th m lody a d l gain ac cord g to H lmh lt t t ll gibl wh the t f m cal scal re ed Tl

ant, and th tl wh l re l ss m ked re th octa tl tw lfth tl seco d oct &c all harm m f tl f d m t l p d m t t any t t f scal l m v f

comm —tl t s, h w ld hoo f mus so g t wh h b l g t m cal scal B t if t be furth asked wh m l to es t cert d an l l thm g man and th animal pl as re w an m g e tl aso than f tl pl asant ss f cert tast and ll Tl t th d g pl as re f som k nd t m ls, m f f th ir be g prod ced d g th aso f

F ts f tl m l and tl compl tru t re ft posse sed b tl m l w ld b se less and th t mpos bl t b l

lif tl y hed amo gst u myst n are pres n m n of so d ff n th t r and th and un ting rem th r n m g t the n ti s of w st rn r t m t ly connected as tl y are by

Song f joy n l da ce accompaniments are n l g as w th us, n tl maj r Key b t tl m n r Wh tl r n t tl half

l t s w k w tl t m n possessed t se

g t t t num l Tl a t f g g and f d

off pring f so g likew so ancient th t many persons h e f lt ast nished that t sh uld h arisen d r g tl arl t ag f

tl int f Africa. B t th re s n thi g

Se eral cco t h bee p bl hed t th ffect. M l ach rites t m that ld d g f his howls b B ff t so ded th fl t d to no other l m add th nst ce of d g al y h g h t co certina, h h t f t as pl yed
M R. B n, P oc Zool. Soc 1868, p 410

ge

taught to do so thus a house parrow has learnt the song of a linnet As these two pe cies are closely allied and belong to the order of Insessores which includes nearly all the singing birds in the world it is possible that a progenitor of the sparrow may have been a so [illegible] ots [illegible] ses [illegible] ocal o gans can be taught not only to peak but to pipe or whistle tunes invented by man so that they must have some musical capacity Nevertheless it would be very rash to as ume that parrots are descende l f om [illegible]

[illegible] u for one purpose having been utilised for some distinct purpose [6] Hence the capacity for high musical development which the sav age races of man possess may be due either to the practice by our semi human progenitors of some rude form of music or simply to their having acquired the proper vocal organs for a different purpose But in this latter case we must assume as in the above instance of par rots and as seems to occur with many anim l that they already possessed some sense of melody

Music arouses in us various emotions but not the more terrible ones of horror fear rage &c It awakens the gentler feelings of tender ness and love which readily pass into devo tion In the Chinese annals it is said Music hath the power of making heaven descend upon earth It likewise stirs up in us the sense of triumph and the glorious ardour for war These powerful and mingled feelings may well give rise to the sense of sublimity We can concentrate as Dr Seemann observes greater intensity of feeling in a single musical note than in pages of writing It is pr bable that nearly the same emotions but much weak er and far less complex are felt by birds when the male pours forth his full volume of song in rivalry with otl e males to captivate the fe male Love is still the commonest theme of our songs As Herbert Spencer remarks music arouses dormant sentiments of which we had not conceived the possibility an l lo not know the meaning or as Richter says tells us of things we have not seen and shall not see Conversely when vivid emotions are felt and expre sed by the orator or even in common speech musical ca lences and rhythm are in stinctively used The negro in Africa when ex cited often bursts forth in son another will reply in song whilst the company as if touch ed by a musical wave murmur a chorus in per fect unison [37] Even monkeys express strong feelings in different tones—anger and impa tience by low —fear and pain l y high notes.[38] The ensations and ideas thus excited in us by music or expressed by the cadences of ora tory appear from their vaguene yet depth like mental reversions to the emotions and thoughts of a long past age

All these facts with re pect to music and im pas ioned peech become intelligible to a cer tain extent if we may assume that musical tones and rhythm were used l y our half hu man ancestors during the season of courtship when animals of all kin ls are excited not only by love but by the strong pas ions of jealou y rivalry and triumph From the deeply laid principle of inherited associations musical tones in this ca e would be likely to call up vaguely and in lefinitely the strong emotions of a long past age As we have every rea on to suppose that articulate peech is one of the latest as it certainly is the highest of the arts ac juired by man an l as the instinctive po er of producing musical notes and rhythms is de veloped low down in the animal eries it would be altogetl er opposed to the principle of evolution if we were to admit that man s mu ical capacity has been developed from the tones used in impassioned speech We must sup pose tl at the rhythms an l cadences of oratory are deriv d f om previously developed musical powers [39] We can thus understand how it is

[illegible]

vantage as [illegible] po bl wh ch th [illegible] con prehended in its [illegible] to sh w [illegible] pl has an imp rta [illegible] m n f some of h [illegible] ct rist cs.

[illegible] peech [illegible] has bee [illegible] first [illegible] p g nt rs of m [illegible] f ch rm g the

that music, dancing, so g and poetry are such very ancient arts. We may g en furth r than this, and as remarked in a former ch p- te beh that mus cal sou d aff rded ne of th bases f r tl e d l pm nt f lang ag

As the m l f sev ral quadruman u ani mals l e tl ocal gan m l m e d loped tl an tl e f mal s, and as a g l b n, of th anth pom rph apes, pou s f tl wh le oct f m cal not and m y b said t it ppears probabl th t tl pro- genitors f m n th th mal s f m l or both se es, bef re acq ri g th pow r of pressi g th m tual l n articul te lan gu ge, dea red t charm ach the w th m cal t and h thm So l ttl s kn wn abo t th se f the ce by the Q adrumana during th season f l tl at w h no m ans f j dgi g wh the th hab t f n g as first acquired by m l f mal an ... rs W m g n rally th ght t pos-

ttract th th se B t if so tl mu ha occurred l g ag b f re u ance t rs had becom ffici tl h man t tre t and al th ir w m n m rel as sef l l Tl mpassio ed t bard m ci wh n th h aned t and cad nce h t th tro g t m t ns n h h ar rs, littl u pects th t h use tl sam m ns by wl h his half h m ance t rs l ng g aroused ach th ard t pass ns, d ri g th ir courtsh p and ri lr

The I fluenc f B a ty determ g the M ag f M nk d—I ci lised l f man is larg l b t b n m ans l l fl

enced the cl o ce of his wif by external ap- pearance but w are ch efly concerned with prime l t m s, and r only means of form ng a j dgm nt n tl i bject i t tu l the l ab- ts of existi g semi-ci il sed and sa ge na ti ns. If it can be shewn tl t the men f d ff r nt races p f r w men h ng ari u har act ri tics, o con r ly w th the women, we ha th n t nq wl th r ucl cl o ce con t nued d ri g many gen r t o is, w uld produce any en bl ffect on the race e tl r ne sex or b th accord g to th form of inheritance wh ch has pre ailed

It will b w ll first to shew in some d ta l th t sa ag s p y th gre te t ttent nt th ir perso al ppearan e That th y l a a pas- n f ornam nt i ot ri s and an Engl sl phil so s so far as to maintain th t loth f w h w a pl a gance dec f l tature gain by th l bou f a f tnigl t to procure n cl ng th *hica* necessary to pai t himself red Th anc ent barbarian f E rope dur ng the R ndee period bro ght to the c s brill ant s gular bjects wl i h th y b ppe ed to find S g t tl p esent d v e wh deck th msel e with pl mes, neckl th m If j l au as l thed n t ns, t w ld l e been pe cei ed th t th most f rt l imagi t n d them t mutabl caprice h ted th fash f painti g as w ll as th se f garm nts

ppos t se Thus mus cal t es becam firmly as- sociated th som of th tro gest passi ns nimal capable of feel g d ar co seq tly used n t cti l thro gh assoc tio wh stro g m are p essed speech M pen- cer does ot ff y satisf ct ry planati ca l, b h gh deep tes should be xpress both th ir d th l imals, f certa moti ns. M pe cer g es lso t rest g dis- cuss th rela ns bet poetry ec t li nd so g

I fi d Lord M bodd *Orig f La gu g* L l 4 p 4 9 th t D Bla klock l k ise tho ght th t th first la guag mo g m w mus d th t bef re ur d as re pressed by art cul t so nds, th y re commun cated by t es varied accord g t diff re t d grees of gra ty d cut ess.

See t resti g discuss this bject by Haeckel, *Gener lle Morphologie* B n., 1866, s. 246

Humboldt, *Per onal* *t* E g translat. L p 51 th m gi t sh w p ti g th body p 522 modify g th f m of th calf of th l g p 466

taught to do so thus a house parrow has learnt the song of a linnet As these two species are closely allied and belong to the order of Insessores which includes nearly all the singing birds in the world it is possible that a progenitor of the sparrow may have been a songster It is more remarkable that parrots belonging to a group distinct from the In es sores and having lifferently constructed vocal organs can be taught not only to speak but to pipe or whistle tunes invented by man so that they must have some musical capacity Nevertheless it would be very rash to assume that parrots are descended from some ancient form which was a songster Many cases could be advanced of organs and instincts originally adapted for one purpose having been utilised for some distinct purpose [35] Hence the capacity for hi h musical development which the savage races of man possess may be due either to the practice by our semi human progenitors of some rude form of music or simply to their having acquired the proper vocal organs for a different purpose But in this latter case we must assume as in the above in tance of parrots and as seems to occur with many animals that they already possessed some sense of melody

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[35] Sin th h pt w p t d I I valuabl rt l by Mr Chauncey Wright (N th Am n R v w O t 18 0 n ... l ... d s- Th ... t h. ... tt pted to h in an e rly ch pt f tl w k th p ... c ple h n mp rta t b g o tl equ tt by man f s m of h s n nt l ch t ist es.

... n ... h h mus c has bee d l ped h lst l co el d tl t mus al tes d hyth fi t eq ed by th m l r f male p og n t rs f m k d f tl sak f ch rm ng th

unnaturally modified has escaped The amo nt of uff ring thus ca sed must ha b n x trem f r many f th operati ns r qu re eraly ars f the compl ti n so th t tl e d a d th ir ecessity m t b mperat Th mo ti es are an th m p int tl e bod es to mak th msel pea t rribl n battl ce tain m t l t as re nnected w tl l gous t s, tl y m k tl ag f pub rty th ank f th m or tl v serv t d s-tinguish the t b l m g t sa ag s tl sam f l g periods,[10] and tl

tion of th rs, seem t b u ou ti es. I regard t tattoo g I was t ld b the miss N w Ze land that wl n they tried to pers ad so g ls t g up tl practice tl y ns ed W m t ju t h f w h n our l p lse wl g w ld e hall be so y gly W th th m n f N w Ze la d m t p bl judg says, to h fi tattooed face n tl g t m b two f th y g b th to d th msel s ttr cti t th lad s, and con p u u n war A t tattooed th f l ad and a spot th chi tl ght b th w m n n h t l l tt ac

t

th gh artly th w m n re ru rnamented A tl m n ar mad by ages to perf m th gre t t hare f th w k, and as th y are n t ll ed to t tl b t k rro l w th th haract

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rnam ti g th hai p ng

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tin t nati ns, sh uld be d e to trad tion from any comm n source They ind cate tl e lose sim larity f th mind of man to wl at er race l e may b long ju t as d tl e almost u rsal h b ts of dan ng, masquerad g and m ki g de p ctures

Ha ng made th se pr l n n v rem ks on tl adm t n felt by sa ages for arious orna m nt d f r d f rm ties m t un ghtly in our s, l t u se l ow far tl m n are att act ed b th app ar nce f the r women nd wl t are tl d as f b ty I h h ard it main t ed tl t ag re qi t nd ffer nt ab ut the b a ty f tl r wom n lu ng tl em solely as l es t may tl f b well to observe th t tl is co lu n does n t t all g ee with th are wl h the nen take in rnam nting th msel s, w th tl r nity Bu l ll[55] g n am ng account f a bu l w man wh u ed as m l gr ase ed ochre and h n ng powd as w uld ha ed an but a ry ri h hu b d Sh d played lso mu h nity and too d nt consei u n s of her upe nty M W nwood R ade i forms me that tl e n groes of tl w t ast ft n d s-cuss the be uty f tl w m n Som compe-t nt bser rs l a e ttrib ted tl e f arfully comm n p act ce f infant de partly to the d h tl w m n t tain the r good

f pl nts ed f th pu pose f n th w t n Am ri a.[56]

H arn [58] an ll nt bse r wh h ed m y w th th Am can I d ans says, n peaki g f th w m n A k rth rn Ind n wh t b a ty and l w ll answ a b ad fl t fac mall y s, l gh heek b n s, thre f u broad black l ss ach h k, l w f h ad a l g b d lun, a l m y hook n se ta n y h d and b easts h g ng d wn t th b lt P llas, wh ted tl th n parts f the Chi se mp says, the

[10] B ker (Ind l p 210) pe k g f th t f ce tral Af ca say E ry tr be has d t ct d bang g f h f dress g th hai See Agassiz (J rney B zil 1868 p 318) ariability of th tattoo g of Amazo ia Ind ns.

Re R. T yl New Z al nd nd its Inhabitants 1855 p 152

M t gazza, l gg Stud p. 542.

[55] T ls S th Afric 1824 l. i., p 414

[56] See, f ref ces, G ls d Über das Aussterben der Nat rvölker 1868 ss. 51 3 5a als Azara, V y g d t m p 116

[57] O th g tabl prod cti ns used by th rth west Am rica l dians, se Pharmac utical J nal, t.

[58] A J rney f om Princ f Wale F t, 8 o. ed 1 96 p 89

In one part of Africa the eyelids are coloured black in another the nails are coloured yellow or purple In many places the hair is dyed of various tints In different countries the teeth are stained black red blue &c and in the Malay Archipelago it is thought shameful to have white teeth like those of a dog Not one great country can be named from the polar regions in the north to New Zealand in the south in which the aborigines do not tattoo themselves This practice was followed by the Jews of old and by the ancient Britons In Africa some of the natives tattoo themselves but it is a much more common practice to raise protuberances by rubbing salt into incisions made in various parts of the body and these are considered by the inhabitants of Kordofan and Darfur to be great personal attractions In the Arab countries no beauty can be perfect until the cheeks or temples have been gashed [44] In South America as Humboldt remarks a mother would be accused of culpable indifference towards her children if she did not employ artificial means to shape the calf of the leg after the fashion of the country In the Old and New Worlds the shape of the skull was formerly modified during infancy in the most extraordinary manner as is still the case in many places and such deformities are considered ornamental For instance the savages of Colombia deem a much flattened head an essential point of beauty

The hair is treated with especial care in various countries it is allowed to grow to full length so as to reach to the ground or is combed into a compact frizzled mop which is the Papuan s pride and glory [45] In northern Africa a man requires a period of from eight to ten years to perfect his coiffure With other nations the head is shaved and in parts of South America and Africa even the eyebrows and eyelashes are eradicated The natives of the Upper Nile knock out the four front teeth saying that they do not wish to resemble brutes Further south the Bakotas knock out only the two upper incisors which as Livingstone[47] remarks gives the face a hideous appearance owing to the prominence of the lower jaw but these people think the presence of the incisors most unsightly and on beholding some Europeans cried out Look at the great teeth! The chief Sebituani tried in vain to alter this fashion In various parts of Africa and in the Malay Archipelago the natives file the incisors into points like those of a saw or pierce them with holes into which they insert studs

As the face with us is chiefly admired for its beauty so with savages it is the chief seat of mutilation In all quarters of the world the septum and more rarely the wings of the nose are pierced rings sticks feathers and other ornaments being inserted into the holes The ears are everywhere pierced and similarly ornamented and with the Botocudos and Lenguas of South America the hole is gradually so much enlarged that the lower edge touches the shoulder In North and South America and in Africa either the upper or lower lip is pierced

a curious account of the shame felt by a South American native and of the ridicule which he ey

iate the lower lip and wear a crystal which from the movement of the tongue has a wriggling motion indescribably ludicrous during conversation The wife of the chief of Latooka told Sir S Baker[48] that Lady Baker would be much improved if she would extract her four front teeth from the lower jaw and wear the long pointed polished crystal in her under lip Further south with the Maka

project two inches beyond the tip of the nose and when the lady smiled the contraction of the muscles elevated it over her eyes Why do the women wear these things the venerable chief Chinsurdi was asked Evidently surprised at such a stupid question he replied For beauty! They are the only beautiful things women have men have beards women have none What kind of a person would she be without the pelelé She would not be a woman at all with a mouth like a man but no beard [9]

Hardly any part of the body which can be

[44] *The Nile Tributaries* 1867 *The Albert N*

Travels p 533

The Albert N yanza 1866 vol i p 217

Livingstone *British Association*, 1860 report given in the *Athenæum* July 7 1860 p 29

according to Madam Pf iff r a be uty A m n of Cochin China poke with contempt f the wif of th English Amba sad r th t she had but teeth like a d g and a rosy col ur lik that of potato-fl s. W ha seen that the Chi ese dislik ur whi t k n, and th t the N Americans admire a t wny hide In S. America, the Yuracaras, wh inl b t the h t rn Cord l

k

n

theless they —

inferio to th ir wn.[52]

In se eral of th tribes f N th Am rica the l h h ad grow to a w nd rf l l ngth l

re — —

hair of any man in th tribe nam y and se in hes. The A maras and Queel as of S. Am rica, lik wise ha e ry l ng hair and thus, as Mr D F bes inf rms m is so much al ed as be t th t tting t off was the sev rest punishm t whi h h could inflict them. I both th n th rn and southern hal f th co ti t th nat es sometimes increase th ppare t l ngth of their hair by w g nt t fibrous ub tan ces Altho gh th hair n th h ad is th ch rished, that n th face con d red by th N rth American Indian as ry ulgar and ry hai is arefull rad cated Th s practice pre ails thro gh t th Am rican continent from Vancou I land th north t T rra d l F g n th so th Wh n Y k Minst F gian n board th *Bea* g k h k t his country th na l

— —

t m *tron h m naked and pl k th* ...

d t wish to be lik h rses.[54]

It is remarkabl that thro gh t th w ld the races wh h are aln ost completely desti tute f a beard dislik hairs on the face and body and take pains to erad cat th m. The Kalmucks are beardl ss, and th y are well known l k the Am ricans, to pluck out all st aggl ng hairs and so it is with the Polyne- ans, some f th Mala s, and th Siamese Mr V t l tate that the J pan e lad s all bjected to ur whi k rs, consideri g th m ry gly nd t ld us t cut th m off and be like Japanese m n Th New Zealand rs ha e sh rt, u led b ards y t th f rm r ly plucked ut th hairs n the face Th y had say ng that th re is no w man f r a hairy man but it w uld appear th at th e fashi n has hanged n N w Zealand perh ps ow g t the presence of E ropeans, and I am assured that beards are n w admired b the Maori s.[64]

O the oth r hand bearded races admire and greatl alue th r b ards am ng th Anglo-Sa ... had a recognise t m te ing of a the East m W ... —

W ha seen th at Chinsurdi the ch f of the Makalol n Africa, th ght th at beards re gre t rnament. In th Pacific the F j an s beard is prof se and bushy and s his gre t est prid whilst th inhab tants of the adjacent arch pelagoe of T nga and Samoa are beardl ss, and abh r a rough chin. In land f ne f th Ell ce gro p th m n are h l bearded and not a littl proud th reof [66]

W thus see h w wid ly th diff rent races of man diff in th tast fo th be utiful. In y nat n uffi ntly ad anced t h mad ffigies of th gods f th r d ified rul rs, th sculptors no d bt ha nd a u ed to exp ss th high t ideal f be uty and grand ur[67] Und r this point of w it i w ll to compare in mind th J p t Apollo of the Greeks w th th Egyptian or Assyrian t tues and th se with the hideous bas-relief n th ruined building of C ntral Am rica.

[52] For the J an nd Cochin-Chinese see Waitz, *Introduct to Anthropology* E g. translat. l. i., p. 305 O th Yuracaras A d Orbig y as q ted Prichard, *Physical History f Mank d* ol. 3rd ed p. 4 6

[53] *North America I d ans* by G Catlin, 3rd ed., 1842, vol. p 49 l. p 227 O th nat es of Vanco Isla d, see proat, *Scene nd tud of avage Lif* 1868, p. 25 On the Indians of Paraguay Azara, *V y ges*, t m. ii., p. 105.

[64] O th iamese Prichard, *ibid* vol. p 533. O th J pa ese V tch *Gardeners Chronicle* 1860 p. 1104 O th N w Zealand rs, M t gazza, *V gg Studi*, 1867 p. 526. For th ther nations me t ed, see ref rences in La rence, *Lect on Physiology &c.*, 1822, p. 272.

[65] Lubbock *Origi f Ci ilisation*, 18 0 p. 321

[66] D B nard D s quot M Prichard and thers for these f cts in regard t th Polynesians, in *Anthropolog Rev w* April, 18 0 pp 185, 191

[67] Ch. Comt has remarks t this ffect in his *T ité de Législation*, 3rd ed., 1837 p. 136.

mous ears [57] and Vogt remarks that the obliquity of the eye which is proper to the Chinese and Japanese is exaggerated in their pictures for the purpose as it seems of exhibiting its beauty as contrasted with the eye of the red haired barbarians It is well known as Huc repeatedly remarks that the Chinese of the interior think Europeans hideous with their white skins and prominent noses The nose is far from being too prominent according to our ideas in the natives of Ceylon yet the Chinese in the seventh century accustomed to the flat features of the Mongol races were surprised at the prominent noses of the Cingalese and Thsang described them as having the beak of a bird with the body of a man

Finlayson after minutely describing the people of Cochin China says that their rounded heads and faces are their chief characteristics and he adds the roundness of the whole countenance is more striking in the women who are reckoned beautiful in proportion as they display this form of face The Siamese have small noses with divergent nostrils a wide mouth rather thick lips a remarkably large face with very high and broad cheek bones It is therefore not wonderful that beauty according to our notion is a stranger to them Yet they consider their own females to be much more beautiful than those of Europe [58]

It is well known that with many Hottentot women the posterior part of the body projects in a wonderful manner they are steatopygous and Sir Andrew Smith is certain that this peculiarity is greatly admired by the men [59] He once saw a woman who was considered a beauty and she was so immensely developed behind that when seated on level ground she could not rise and had to push herself along until she came to a slope Some of the women in various negro tribes have the same peculiarity and according to Burton the Somal men are said to choose their wives by ranging them in a line and by picking her out who projects farthest *a te go* Nothing can be more hateful to a negro than the opposite form [60]

With respect to colour the n gro 1

... ... as unsightly and unnatural conformations He in return praised the glossy jet of their skins and the lovely depression of their noses this they said was honeymouth nevertheless they gave him food The African Moors also knitted their brows and seemed to shudder at the whiteness of his skin On the eastern coast the negro boys when they saw Burton cried out Look at the white man does he not look like a white ape On the western coast as Mr Winwood Reade informs me the negroes admire a very black skin more than one of a lighter tint But their horror of whiteness may be attributed according to this same traveller partly to the belief held by most negroes that demons and spirits are white and partly to their thinking it a sign of ill health

The Banyai of the more southern part of the continent are negroes but a great many of them are of a light coffee and milk colour and indeed this colour is considered handsome throughout the whole country so that here we have a different standard of taste With the Kaffirs who differ much from negroes the skin except among the tribes near Delagoa Bay is not usually black the prevailing colour being a mixture of black and red the most common shade being chocolate Dark complexions as being most common are naturally held in the highest esteem To be told that he is light coloured or like a white man would be deemed a very poor compliment by a Kaffir I have heard of one unfortunate man who was so very fair that no girl would marry him One of the title of the Zulu king is You who are black [6] Mr Galton in speaking to me about the natives of S Africa remarked that their ideas of beauty seem very different from ours for in one tribe two slim slight and pretty girls were not admired by the natives

Turning to other quarters of the world in Java a yellow not a white girl is considered

Quot d by Pr ch l Phy al H to y f M ki d 3 d d v l iv 1844 p 19 V gt l t n M E g t nsl t p 129 O th j n of the Chi e the Cing l L T t C ylo 1859 vol ii p 107

l i hard t k n from C f rd l F l

q nd m perm g io a t rt b hom b n hac gente V nc res mutata e t t censent talem co formatio em m m opt ndam esse

Th Anth pol g l R v w N ember 1864 p 237 F dd t n l f c vs, ce W t Int o d t to l thr pology L g tr nslat 1863 ol p 105

M g I ks T l n lf 4t 1810 pp 53 131 Burt n tat nt is qu ted by Schaaff h us A l v f A th opol g 1866 s. 163 On the B ny l g t n T v ls p 64 On the K ffi s, th Re J Shooter The K f s f Natal nd the Zulu Co nt y 1857 p 1

actly tl sam prin pl a d tl sai le t h wever p ss ble tl at certain ta t m y carry ery po t t a ext me w l l it the ou f t m becom i lented tl igl also, th sam sp t f mulat n B t tl e th f of tl s bel ef f h ns of sa ag s re f m pe manent and nat than ur and wh tl bod are art gu u fi ally mod fied tl ece saril the case tl tru ture f tl lo r Tl Arab w m n f tl e Uppe N le occupy d bt tl si pa tly t ue tl tl n rece l sed abo t three d s d ng tl l a th y n t n n wh l t llect l gl ly app eci m tate the t b l t mply e ted b t th expla t n will l dly apply to h th th upe l t ss f th r all f rms f ughn ss Tl m n f acl ce p e i f tl fer wl t th y accu t ned t th v e nn t ndure any g t cl ng but tl ey lik an ty nd dm re acl l act i t carried to a mod t ext en M n accu t med to a n l l face t tr gl t ar d g l r f t re n l t l rigl t l u adm e as w ai l tl rt i European kn tl se po ts l en t ongly d l ped On tl tl r l an l m n accu t m ed t b d f ce w tl l l l eck b n s a l pre sed n se and a black ha dm re tl se ha been k pt m rely f rnam t pec l t wh t ngly m ked No doubt i t t b som wh t n h act rs f ll k d m y b too muc l d l ped f b uty H nce a p rfect b ty wh h mpl m ny l act rs mod fied in a p t ul man r w ll be n rv ace a p od gy As tl gre t anat m t B cl at long g d if ery we ast n th sam l th ng as b uty m ld

If ll be so co t tuted tl t brill ant as tl ta f rms, as w ll as l rm us d b l i cal so ds, gi pl a d ar ll t tif l b t wl th l ld b so w w l t It cert ly t t tl t tl re g mind f ma n u sal tandard f t dard y tl re pect t th h m body It

uthsonia Instit t 1863 p 289 O th f Arab w m S Bak The Nile t re 1867 p 121 The Variat on f A mals nd Plants nd Do- ation, l p 214 l p 240

Sch ffhausen, Arch f Anthr pologi 1866 qu th sam

I have met with very few statements op posed to this conclusion Mr Winwood Reade however who has had ample opportunities for observation not only with the negroes of the west coast of Africa but with those of the in terior who have never associated with Europeans is convinced that their ideas of beauty are *on the whole* the same as ours and Dr Rohlfs writes to me to the same effect with re spect to Bornu and the countries inhabited by the Pullo tribes Mr Reade found that he agreed with the negroes in their estimation of the beauty of the native girls and that their appreciation of the beauty of European women corre ponded with ours They admire long hair and use artificial means to make it appear abundant they admire also a beard though themselves very scantily provided Mr Reade feels doubtful what kind of n

t

d

[illegible] however bear in mind that the de pressed broad noses and projecting jaws of the negroes of the west coast are exceptional types with the inhabitants of Africa Notwith standing the foregoing statements Mr Reade admits that negroes do not like the colour of our skin they look on blue eyes with aversion and they think our noses too long and our lips too thin He does not think it probable that negroes would ever prefer the most beautiful European woman on the mere grounds of physical admiration to a good looking ne gress [68]

The general truth of the principle long ago insisted on by Humboldt [69] that man admires and often tries to exaggerate whatever charac ters nature may have given him is shown in many ways The pra t [illegible]

The skull has been greatly modified during an cient and modern times by many nations and there can be little doubt that this has been practised especially in N and S America, in order to exaggerate some natural and admired peculiarity Many American Indians are known to admire a head so extremely flattened as to appear to us idiotic. The natives on the north western coast compress the head into a pointed cone and it is their constant practice to gather the hair into a knot on the top of the head for the sake as Dr Wilson remarks of increasing the apparent elevation of the favourite conoid form The inhabitants of Arakhan admire a broad smooth forehead and in order to pro duce it they fasten a plate of lead on the heads of the new born children On the other hand a broad well rounded occiput is con sidered a great beauty by the natives of the Fiji Islands [70]

As with the skull so with the nose the an cient Huns during the age of Attila were accus tomed to flatten the noses of their infants with bandage for the sake of exaggerating a nat ural conformation With the Tahitian to be called *long nose* is considered as an insult and they compress the noses and foreheads of their children for the sake of beauty The same holds with the Malays of Sumatra, the Hottentots, certain Negroes and the natives of Brazil [71] The Chinese have by nature unusually small feet and it is well known that the women of the upper clas es distort their feet to make them still smaller Lastly Humboldt thinks that the American Indians prefer colouring their bodies with red pa t [illegible]

[illegible] may be doubted whether barbarous nations have generally had any such intention in painting themselves

In the fashions of our own dress we see ex

n Af n Sk t h R [illegible] pp 253 [illegible] med by [illegible] but f m [illegible] t we na n f th j dgm nt f th th r b-or gines f Am r ca, I cann t b t th nk th t th must be a mist k u l ss d ed th t t ment r f rs to th few k u g s who ha l d f r s me time with Europ an nd wh must on d us as super b ng I hould add th t m t pe-rienced obs C pt. Burt b l th t a wom n whom we con d r b a tif l is dmired throughout the w ld. *Anth opol g al Review* March 1864 p 245

[69] *Personal N rr t ve* Eng tr sl t v l v p 518 and el wh e. Ma teg z a, n his *Viaggi e Studi*, strongly insists n this same principle.

[70] On th k lls f th Ame c n tr bes ee Nott d Cl dd *Type f M nkind* 1854 p 440 Pr ch rd *Phys al Histo y f M k nd* vol 3rd d p 321 on th at e f Ar kh n *ibid* v l. p 537 W ls n *Phys al Eth nol gy* Sm ths n I t tu ti 1863 p 288 n th F j ns, p 290 Sir J L b k (*P ehi tori T m* 2 d d 1869 p 06) gives [illegible] celle t résumé this subj ct.

[71] On th Hu Godr n *D l'E pèce* t m 1859 p 300 On th T h ti ns Wa tz *Anth pol gy* E g translat. v l p 305 M rsd n qu ted by Prich ard *Phy Hist.* f *M nkind* 3rd ed t. v l. p 67 La rence *Lect* s o *Physiology* p 337

[72] Th f t was asc rta ed n th *Reis der Nov* *Anth opolog Theil.* Dr W isbach 1867 s 265

famous as the most be tiful n tl land nd e sought by arti ts as mod ls. B t t is b- vious that th e d ce n all the abo e ases is doubtf l.

The f llo ing case tl ugh relat g t sav ages, is ll w rth gi g f t curious Mr Win ood R ade nf rm m th t the J ll fs, a t be of negroes n th w t coa t of Africa, are remarkabl f r th ir unif rml fi e p- pearance A friend f l a ked n of these men H w is t th t e ry wl m I meet is so fin looking, not only m but o omen Th J llof a w red It is ery asl plained t has al s been r cu t m t pick t ou rst looking sl and t sell them. It need hardl be added th t tl all sa ages, f m l sla se as co cub That this rosh uld ha tt l ted wl tl ...tl wro gl th fi ppe rance f l true t th lo co ti ed l mun t n f tl l m n n t so rprisi as t n t first ppear for I h bewh re sh wn th t ne roe full pprec t tl po tan e f select th breed g f tl d m ti animals, and I co ld from M R de add tional vid ce this l d

The C use wh h p ert heck le ict f Sexual S lect until S —Th h f ca ses are first so-call d co n l m rri ges or promiscu us t recourse second th consequ nce f f mal f t l tl rdl earl)) ll tl tl lowest m t n m f

man. f an tl an al l lt t m re liance n th to l ce rted b th se there can be e u l selectio and ffect will be prod ce l tl ff pring h erta od d l l g i d ad a t g others tl c t h p N w t asserted that th re t tl present d tribe wh h practise wi t S J L bbock l co te alls commu al marri tl t is, all tl m d w m th tribe re l sband d w t one another Th lece t nes f man sa age d l t a t) g b t t seems t m th t m r d e req t bef re w f ll ad t that tl t o r is in any ase p m se rth l ss all thos who ha mo t losel t d ed th bject, and

wl ose judgment is worth much more tl an n n bel tl t commun l marriage (this expressi be g ar u l guarded) was tl e origin l and un ersal f rm througl o t the w rld l d tl re n tl at rmarri ge of brotl rs and s t rs. The l te S r A Sm tl wl o had tra lled wid ly n S Africa, and kn w much abo t tl e l b ts of sav g th re l bewl re pressed to m tl e stro gest p n tl t no race t n wh ch om n is co d red as tl e prope t of tl e co n n t I b l that l is j dgme t was larg ly l t rmi ed l what i mpl ed by tl e t n n ar riage Tl rougl ut th f llow g d scus n I use tl term in tl sam nse as wl e n tu alist peak of an mal as mono mous, m an ng tl reb that tl e male i accepted by r l ose gle f m l and l e with l r tl l r th breed g seaso r for tl wl l y ar keep g possessi n f l b th law of m gl t as wl n tl y pe k of a pol ga is pec s, m an g tl t tl mal l es w tl se l f n l s. Thus k d f mar g all tl t concern u l re as t ul ces f tl k f sexu l select n B t I kn w tl t so f tl t rs bo e ref red to jl t tl t rm marri g a recog sed right p t cted l th tribe

ll nd rect f ce n fa f tl bel f l tl f m pre al nce f communal mar riage tro nd rest l fl o tl t rm f l t l p wl h are mpl ed between th m mbers f tl sam tribe impl a connection w th tl t be and t w tl tl r pare t B t tl bject is too larg and o pl f n an ab tract to be h re gi n, and I w ll co fi m lf to f w remarks. It d t th case of h mar g s o wl re tl mar g t is loose th t th rela t n l p of th h ld t t f th eam t l e k wn B t t seems lmo t red bl th t tl relatio l p of tl child to ts m th h ld be complet ly no ed pec all as the w m n n most sa g tribe nurse tl n

[1] ation f A mals nd Plants nder Dom sti cation, ol p. 207

[2] J Lubbock, *The Orig of C ilisation*, 1870, hap iii especially pp 60-67 M M Le nan,

lassificat y t m of relatio h p. (*Proceed g J the Amer ca Academy of Sci nce* L iii, F b 1868, p. 4) concludes that pol gamy nd ll f rms of marriage during pr me l times re s- se tiall nknow It ppears lso fron Sir J Lubbock work, that Bachof l Le ise belie es that comm nal int recourse n inall pre ailed

CHAPTER XX

SECONDARY SEXUAL CHARACTERS OF MAN—*Continued*

We have seen in the last chapter that with all barbarous races ornaments dress and external appearance are highly valued and that the men judge of the beauty of their women by widely different standards We must next inquire whether this preference and the consequent selection during many generations of those women which appear to the men of each race the most attractive has altered the character either of the females alone or of both sexes With mammals the general rule appears to be that characters of all kinds are inherited equally by the males and female we might t[illegible]fore expect that with mankind any char [illegible]

[illegible] certain that the different races would be [illegible]ferently modified as each has its own standard of beauty

With mankind especially with savages many causes interfere with the action of sexual selection as far as the bodily frame is concerned Civilised men are largely attracted by the mental charms of women by their wealth and especially by their social position for men rarely marry into a much lower rank The men who succeed in obtaining the more beautiful women will not have a better chance of leaving a long line of descendants than other men with [illegible] e the few who bequeath [illegible]

namely of the more attractive men [illegible] women although in civilised nations women have free or almost free choice which is not the case with barbarous races yet their choice is largely influenced by the social position and wealth of the men and the success of the latter in life depends much on their intellectual power [illegible] or on the fruit of these same [illegible] neede[illegible] for as [illegible] remarks the final aim of all love intrig[illegible] be they comic or tragic is really of more importance than all other ends in human life What it all turns upon is nothing less than the composition of the next generation It is not the weal or woe of any one individual but that of the human race to come which is here at stake [1]

There is however reason to believe that in certain civilised and semi civilised nations sexual selection has effected something in modifying the bodily frame of some of the members Many persons are convinced as it appears to me with justice that our aristocracy including under this term all wealthy families in which primogeniture has long prevailed from having chosen during many generations from all classes the more beautiful women as their wives have become hand[illegible] to the European standard [illegible]

of life for the perfect development of [illegible] Cook remarks that the superiority in personal appearance which is observable in the erees or nobles in all the other islands (of the Pacific) is found in the Sandwich Islands but this may be chiefly due to their better food and manner of life

The old traveller Chardin in describing the Persians says their blood is now highly re[illegible] [illegible] mixtures with the [illegible] is hardly a man of rank in Persia who [illegible] born of a Georgian or Circassian mother He adds that they inherit their beauty not from their ancestors for without the above mixture the men of rank in Persia who are descendants of the Tartars would be extremely ugly [2] Here is a more curious case the priestesses who attended the temple of Venus Erycina at San Giuliano in Sicily were selected for their beauty out of the whole of Greece they were not vestal virgins and Quatrefages who states the foregoing fact says that the women of San Giuliano are now [illegible]

[1] [illegible] Journal [illegible]

[illegible] lected [illegible]

[illegible] Revue des Cours Scientifiques Oct 1868 p 721

hat social th chimpanzee for nstance, is occasionally met with in larg bands. Again, other species are pol gam us, but sev ral males, each with his n femal s, l associated in body as with se eral peci s of baboons. W may indeed con lud from what we know of th j alo y of all male quadru peds, armed, as many f them are w th pecial eapons f b ttling with th ir ri als, that promiscu us intercourse in a tat f n ture is extrem ly improbable. The pairi g may n t ast for life, b t nly f ach b rth yet if the mases which are th strongest and be t abl to defend r therwise assist th ir f mal s and oung, were t select th m re att acti e females, this w uld suffice f sexual selecti n.

Theref re, looking far n gh back in th stream of time, and judging from th social hab ts of man as h n w xi ts, the m t probable vi w is that h aboriginally h ed in mall communiti s, each with singl wif if po d l with se al, wh m he j al u ly guarded gainst all th m n. O h may not ha bee social animal, and v t ha h ed with se ral wi es, lik th g rilla f all th nati gree th t b t n adult male is seen in band wh n th y ung mal grows up a co test takes place f ma t ry and th stro est, by killing and drivin ut th thers, establish himself as th h ad of th communit [30] Th ung males, be g thus xpelled and wand ring abo t, w uld, wh n t last ccessful in findi g p rtn pre nt too lose inte breeding within th limits of the same family

re n w trem ly h

that death al n can separate husband and wif An int llig nt Kandyan chi f of course a pol gamist, was *perfectly* scandalised at th utter barbari m of l ng w th onl one wif and n r parting unt l separ ted by death. It was, he said just l k the Wan d oo m nk " Wh ther sa ages wh now nt r nto som f rm of marriage ther polygamou o mon gam us, ha e retained this hab t from prim val times, r wh ther they l returned to some form of marriage aft passing through tag f prom scuous int rcourse I will not pret nd to conjecture

I f nt cide —Thi p actice is now erv comm n throu h ut the w ld and there reason t beli that t pre ailed mu h m re t ns l during f rm tim [31] Barbarians find t difficult to pport tl msel and th ir children, and t is a simpl plan to kill tl eir nfants. In South America som tribes, according to Azara, f rm l d troyed so many infants of both se es that th y w re n the point of extin ti n. *In th Polyn sian Island* w m n h been kn wn to kill from f ur or fi to en ten of th h ldren and Ellis could n t find ingle w *man* who had n t killed at l ast In a ll g on th astern front of India Col n l MacCulloch f und n t m l f mal ch ld Wh re nfanti cid pre ails the truggl f exist nce will be in so far l ss sev re, d all th m mbers of th tribe will ha e an almost equally good chance f rearing th f w rvivin children. In m t case larg numbe of f mal than of mal infants are destroyed f t is b us that th latte are f m re alu to th tribe will wh n grown p aid n d f nding

lised nations. P l gam as just
almost uni rsall f ll wed b th l ading m rv tribe N rth l ss th re are tribes, standing alm t t th bottom f th scale hich are tri tl m gam s. This is the case with th Veddahs f Ce l n they ha sa ing, according to Sir J Lubbock,

high tim ti n set n th m wu n th happ f te, are assigned by th w m n th msel es, and by ari us bserv rs, as addi ti nal m ti es f infanticide.

Wh n, wing t f mal infanticide th

Brehm (*Illustrirtes Thierleben*, B i., p.) says *Cynocephal hamadryas* li es in gre t troops containing twice as many adult f males as adul males. See Rengge America pol gamous pecies, and Owen (*Anatomy f Vertebrates*, ol iii., p. 46) American m nogamous pecies. Othe ref rences might be added.

Dr Sa age, in *Boston Journal of Natu al History* ol. 1845-4 p. 423.

Pr historic T me 1869 p. 424.

[31] M M'Lennan, *Primiti M rriage*, 1865 See especially gamy and nf ticide, pp 130 138,

this book correct quotatio from was unfortunat ly gi the bov passag and has w been remo ed *from th text*.

fants for a long time Accordingly in many cases the lines of descent are traced through the mother alone to the exclusion of the father But in other cases the terms employed express a connection with the tribe alone to the exclusion even of the mother It seems possible that the connection between the related members of the same barbarous tribe exposed to all sorts of dange [illegible] [illegible] child as to lead to the sole use of terms expressive of the former relationships but Mr Morgan is convinced that this view is by no means sufficient

The terms of relationship used in different parts of the world may be divided according to the author just quoted into two great classes the classificatory and descriptive — the latter being employed by us It is the classificatory system which so strongly leads to the belief that communal and other extremely loose forms of marriage were originally universal But as far as I can see there is no necessity on this ground for believing in absolutely promiscuous intercourse and I am glad to find that this is Sir J Lubbock s view Men and women like many of the lower animals might formerly have entered into strict though temporary unions for each birth and in this case nearly as much confusion would have arisen in the terms of relationship as in the case of promiscuous intercourse As far as sexual selection is concerned all that is required is that choice should be exerted before the parents unite and it signifies little whether the unions last for life or only for a season

Besides the evidence derived from the terms of relationship other lines of reasoning indicate the former wide prevalence of communal marriage Sir J Lubbock accounts for the strange and widely extended habit of exogamy—that is the men of one tribe taking wives from a distinct tribe —by communism having been the orig nal fo [illegible] [illegible] come his sole and valuable property Thus the practice of capturing wives might have arisen and from the honour so gained it might ultimately have become the universal habit According to Sir J Lubbock [6] we can also thus understand the necessity of expiation for marriage as an infringement of tribal rites since according to old ideas a man had no right to appropriate to himself that which belonged to the whole tribe Sir J Lubbock further gives a curious list of facts shewing that in old times high honour was bestowed on women who were utterly licentious and this, as he explains is intelligible if we admit that promiscuous intercourse was the aboriginal and therefore long revered custom of the tribe [7]

Although the manner of development of the marriage tie is an obscure subject as we may infer from the divergent opinions on several points between the three authors who have studied it most closely namely Mr Morgan Mr M Lennan and Sir J Lubbock yet from the foregoing and several other lines of evidence it seems probable[8] that the habit of marriage in any strict sense of the word has been gradually developed and that almost promiscuous or very loose intercourse was once extremely common throughout the world Nevertheless from the strength of the feeling of jealousy all through the animal kingdom as well as from the analogy of the lower animals more particularly of those which come nearest to man I cannot believe that absolutely promiscuous intercourse prevailed in times past shortly before man attained to his present rank in the zoological scale Man as I have attempted t shew is certainly descended from some ape like creature With the existing Quadrumana as far as their habits are known the males of some species are monogamous but live during only a part of the year with the females of this the orang seems to afford an instance Several kinds for example some of the Indian and American monkeys are strictly monogamous and associate all the year round with their wives Others are polyg amous for example the gorilla and several American specie and each family lives separate Even when this occurs the families inhabiting the same district are probably some

6 *Address to British Association On the Social and Religious Condition of the Lower Races of Man* 1870 p 20

7 *Origin of Civilisation* 1870 p 86 In the [illegible] b [illegible] q ted th [illegible] ll b f n l cop [illegible] d co l t n l p thr gh th f m l [illegible] th the t b l

8 Mr C Staniland Wake argues strongly (*Anthropologia* [illegible]) [illegible]

that social the chimpanzee f in tance is occasionally met with in large bands. Again, other species are pol gam us, b t se eral males, each with his wn f mal s, li e associated in bod as with se ral species of baboons. W may indeed conclud from what we know of th j alousy of all mal quadrupeds, armed, as many of them are with pecial weapons for battling with their rivals, that promiscuous intercourse in a state of nature is extremel improbable The pairin may not last for life, b t nly f ach birth v t if th males which are the strongest and best abl to defend or therwise assist th ir f males and young, w re to select th m re ttracti females, this would suffice for sexual selecti n.

Therefore, looking far gh back in th stream of time, and judging from th social ha ts of man as he now xists, the most probable view is that h aboriginally li ed in mall communities, each with singl wif if powerful with se eral, wh m h j alously guarded against all oth m n. O h may not ha been social animal, and v t ha lived with several wi es, like th g rilla f all the nati es gree that b t n ad lt male is seen in band when th y ung male grows p, a contest takes place f mastery and th strongest, b killing and driving t th others, establishes himself as the head of th communit [9] The younger males, being thus expelled and wandering abo t, would, wh n at last successful in findin partn prev nt too lose int rbreeding within th limits of th same famil

Although savages are now extrem ly licentious, and although communal marriages may formerly ha lar ly pre ailed, v t many tribes practise som form of marriage, b t of far more lax nature than that of ci ilised nations. Pol gam as just stated, is almost uni ersall f llowed b th leading men in ery tribe. N rth less there are tribes, standing almost at the bottom of th scale, which are strictl monogamous. This is the case with th Veddahs of C lo they ha saying, according to Sir J Lubbock, that d ath alone can separate husband and wif An int lli nt Kandyan h f of course a pol gamist, "was perfectly scandalised at th utt barbarism f li ng with o ly one wif and ne e partin until separated by death. It was, he said, j t l k the Wan d roo monk y Wh ther sa a es who now nt r into some f rm of marri th r pol gamous r mo ogamous, ha e retained this hab t from prim al times, o wh th th h e returned to some form of marriage aft pas g thro gh a tage of promiscu u intercourse, I will not pretend to conjecture

I f nt cide—Th s practice is now erv comm n thro gho t th wo ld, and th re reason to bel v th t it prevailed m ch m re extensi l during form times.[12] Barbarians find t difficult t s pport th msel es and their children, and t is simple plan to kill th ir infants. In So th Am rica som tribes, according to Azara, f rm l destro ed so many infants of both se es that th w re n the point of xtinction. In the Pol nesian Islands women ha been known to kill from f r fi to n t n of their childre and Ellis could n t find a sin l w man who had not killed at l a t one. In a villa n th astern fronti of India Colon l MacCulloch found not sin l f mal child Wh re infant cid pre ails th tru gl f xist nce will be in so far less se re and all th members of the tribe will ha an almost equally good chance of rearing th ir f w survivin children. In most cases a larg numbe of f mal than f mal infants are destro ed, f it is ob that th latt are of more val to th tribe, as th y will, when grown p, aid in d fendin t, and can support th msel es. B t the tro bl xperi nced by the w m n in re n

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ti nal moti es f infanticide.

Wh n, owing to f male infanticide, th

[9] Brehm (*I ustrierte Thierleben*, B i, p) says *Cynocephalus hamadryas* lives in great troops containing twice as many adult females as adul males. See Rengger on American pol gamous species, and Owen (*Anatomy of Vertebrates*, ol iii, p 46) American monogamous species. Other references might be added.

Dr Savage, in *Boston Journal of Natural History*, ol 1845-6 p 423.

Prehistoric Times, 1869 p 424.

[12] M M'Lennan, *Primiti Marriage* 1865 See especially ogamy and infanticid pp. 130 138, 165.

[13] Dr Gerland (*Ueber das Aussterben der Naturvölker* 1868) has collected much informatio o infanticide, see especially ss. 27 51 54 Azara (*Voyages, &* tom. ii, pp. 94 116) enters detail the motives. See also M Lenna (*ibid.* p 139) f cases in India. In the former reprints of the 2nd edition of this book an incorrect quotatio from Sir *G. Grey* was unfortunately give in the *above passage and* has now been removed from *the text.*

women of a tribe were few the habit of capturing wives from neighbouring tribes would naturally arise Sir J Lubbock however as we have seen attributes the practice in chief part to the former existence of communal marriage and to the men having consequently captured women from other tribes to hold as their sole property Additional causes might be assigned such as the communities being very small in which case marriageable women would often be deficient That the habit was most extensively practised during former times even by the ancestors of civilised nations is clearly shewn by the preservation of many curious customs and ceremonies of which Mr M Lennan l g

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o ice and craft they would have been glad to seize on any woman and would not have selected the more attractive ones But as soon as the practice of procuring wives from a distinct tribe was effected through barter as now occurs in many places the more attractive women would generally have been purchased The incessant crossing however between tribe and tribe which necessarily follows from any form of this habit would tend to keep all the people inhabiting the same country nearly uniform in character and this would interfere with the power of sexual selection in differentiating the tribes

The scarcity of women consequent on female infanticide leads also to another practice that of polyandry still common in several parts of the world and which formerly as Mr M Lennan believes prevailed almost universally but this latter conclusion is doubted by Mr Morgan and Sir J Lubbock [1] When ever two or more men are compelled to marry one woman it is certain that all the women of the tribe will get married and there will be no selection by the men of the more attractive women But under these circumstances the women no doubt will have the power of choice and will prefer the more attractive men Azara, for instance describes how carefully a Guana woman bargains for all sorts of privileges before accepting some one or more husbands and the men in consequence take unusual care of their personal appearance So amongst the Todas of India, who practise polyandry the girls can accept or refuse any man [15] A very ugly man in these cases would perhaps altogether fail in getting a wife or get one later in life but the handsomer men although more successful in obtaining wives, would not, as far as we can see leave more offspring to inherit their beauty than the less handsome husbands of the same women

Early Betrothals and Slavery of Women — With many savages it is the custom to betroth the females whilst mere infants and this would effectually prevent preference being exerted on either side according to personal appearance But it would not prevent the more attractive women from being afterwards stolen or taken by force from their husbands by the more powerful men and this often happens in Australia America and elsewhere The same consequences with reference to sexual selection would to a certain extent follow when women are valued almost solely as slaves or beasts of burden as is the case with many savages The men however at all times would prefer the handsomest slaves according to their standard of beauty

We thus see that several customs prevail with savages which must greatly interfere with or completely stop the action of sexual selection On the other hand the conditions of life to which savages are exposed and some of their habits are favourable to natural selection and this comes into play at the same time with sexual selection Savages are known to suffer severely from recurrent famines they do not increase their food by artificial means they rarely refrain from marriage [16] and generally marry whilst young Consequently they must be subjected to occasional hard struggles for existence and the favoured individuals will alone survive

At a very early period before man attained to his present rank in the scale many of his conditions would be different from what now obtains amongst savages Judging from the analogy of the lower animals he would then either live with a single female or be a polyga

I n t M rriage p 208 S J Lubbock Orig n f C vilis t n, p 100 S lso M M g loc cit n th f n pre lence f poly nd y

lon l

1824 p 55) tl t k tl ld t f so th n Af ca t th pa th r l t t f l b y l r (l y g d nsl Améri q e M d t 1809 p 21) m k p c ely th sa m rk n reg rd t the w ld l d f South Am ca.

est. The most powerful and abl males would succeed best in obtaining attracti f males. They would also succeed best in th ge ral struggle for lif and in d f nding th fe males, as w ll as their off pring, from n m es of all kinds. At this arly period the ancest rs of man w uld t be ffici ntl ad anced in intellect to look forward t distant co tingencies the w uld not f resee th t th rear ng of ad their children, especiall the r f male children, would mak th truggle f life se erer for th tribe. Th y w uld be go rned more by their nstin ts and less by th r reason than are sa es t the prese t da Th y ould not t that period ha partiall lo t one of th stronge t of all instin ts, comm n to all the low r animals, namel th l ve of their own off pr and conseq ntl th y would not ha practised f male infanticide Women would n t ha been thus rend red scarce and poly andry w ld n t ha e been practised for hardly any oth a se cept the scarcit of w m n seems ffici t to break d th natural and wid l pre ale t feeling of jealous and th des re of ach mal to possess femal f himself Pol andry w uld be natural t ppuns t to com munal marria es almost promisc nt course thou th be t thoriti s beli that th latt l b t preceded pol andry Durin primordial times th re w ld be n earl betrothals, for this impl f resig t N would w m n be al d m ly as s f l sa es or beast of burd n. Both se es, f th f males as ll as th ma es w re permitted to ert an h ce w d hoose their partn rs not for me tal charms, prope t social position, b t almost sol l from xt rnal p pearance All the adults w uld marry pai and all the off pring, as far as that was pos sible would be reared so that th truggl f existence uld be periodicall treme ly se re Thus d ri g th se tim all th conditions for se ual selecti w uld ha been m re f ourable than t late period when man had ad anced in his intellectual powers b t had retrograded hi nstincts. Th refore, what ntl nce se al selecti m ha had in producing th diff rences betwee th races of man, and betwee man nd th highe Quad rumana, th infl nce w ld h been more po rful t remot period than t th present d y though probabl not t wholly lost.

The M nner f Action f Sexual Selection with Mankind.—W th primeval man under

th th n p) infanticid arly betrothals, a — and most gorous m n—those wl o could best d f nd and hunt f r th ir famil es, who w re pro ded with the best w apons and possessed th m t property h as a large num ber of d gs o othe animals,—w ld s cceed in rearin a great a rage n mber of off sprin th n th e weak and poorer m mbers of th same tribes. There can also be no do bt that such men w uld gen rall be able to select th m re ttract w men At present th ch fs of nearl ery tribe thro h t th w ld cceed in obtainin more tha o e wif I hear from M Mant ll that, unt l re ce tl almost e ry g l in N w Ze land wl o was prett promised to be pretty was t t f W il th Kaffirs, as M C

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ach race has ts wn t le of beaut and e kn w th t t is n tural to man to admire ach charact r t e point n h d mesti animals, dress, ornam ts, and personal appearance when carried a ttle be nd tl a erage If th n th se ral foreg in proposit n be ad mitted and I cann t see th t th are d ubt ful, t w ld be an in pl cabl re mstance if th select n f th n re ttract w m n b th more po rful m n of each t ibe who w uld rear o an era a gre t numbe of children, did not aft the lapse f many g rations som what modif th charact r f the tribe

Wh n f re gn breed of ou l mestic ani mals is introd ced int n w coun ry o wh n a nati breed is lo g and carefully tt ded to, *th f use o mam nt t s f und aft* se ral g n ratio to ha und rg e a gre t less am unt of chan wh e th means of comparison xist. This f ll w from u conscious selecti n during lo seri f g nerati ns—that is, th preser ti n of th most ppro ed ndi id als—without any wish pectation of ch a result n th part of th breed So gain, if during man ars tw careful breed rs rear animals of th sam family and d n t compare th m t g ther or with a comm n standard, th animals are

Anthropological Review Jan., 1870, p. xvi.

found to have become to tl

... of his own mind—his own taste and judgment—on his animals What reason then can be assigned why imilar results hould not follow from the long continued se lection of the most admired women by those men of each tribe who were able to rear the greatest number of children? This would be unconscious selection for an effect would be produced independently of any wish or ex pectation on the part of the men who preferred certain women to others

Let us suppose the members of a tribe practi ing some form of marriage to pread over an unoccupie l continent they would soon split up into distinct hordes separated from each other by various l arriers and still more effectually by the incessant wars between all barbarous nations The hordes would thus be exposed to slightly different conditions and habits of life and would sooner or later come to differ in some small degree As soon as this occurred each isolated tribe would form for itself a slightly different standard of beauty[19] and then unconscious selection would come into action through the more powerful and leading men preferring certain women to others Thus the differences between the tribes at first very slight woul l gradually and inevitably be more or less increased

With animals in a state of nature many characters proper to the males such as size strength special weapons courage and pug nacity have been acquired through the law of battle The semi human progenitors of man like their allies the Quadrumana will almost certainly have been thus ... s r

... day Other characters proper to the males of the lower animals such as bright colour and various ornaments have been ac quired by the more attractive males having been preferred by the females There are however exceptional cases in which the males r s are the selectors instead of having been the selected We recognise such cases by the fe males being more highly ornamented than the males —their ornamental characters having been transmitte l exclusively or chiefly to their female off pring One such ca e has been de scribed in the order to which man belongs, that of the Rhesus monkey

Man is more powerful in body and mind than woman and in the savage state he keeps her in a far more abject state of bondage than does the male of any other animal therefore it is not surprising that he hould have gained the power of selection Women are everywhere conscious of the value of their own beauty and when they have the means they take more delight in lecorating themselves with all sorts of ornaments than do men They borrow the plumes of male l irds with which nature has decked this sex in order to charm the fe males As women have long been selected for beauty it is not surprising that some of tl eir succe ive variatic ns houl l have been trans mitted exclusively to the same ex conse quently that they should have tran mitted beauty in a somewhat higher legree to their female than to their male off pring and thus have become more beautiful according to general opinion than men Women l owever certainly tran mit most of their characters, including some l eauty to their off pring of both exes o that the continued preference by the men of each race for the more attractive women according to their standard of taste will have tended to modify in the same manner all the individuals of both sexes belongin to the race

With re pect to the other form of sexual se lection (which with the lower animals is much the more common) nam ly when tl e females are the selectors and accept only those males which excite or cl arm th m mo t ... l l

... i cl ar cters to ... il e itance from an ancient progenitor who tl is gained his ornan ents But tl is form of selection may l ave occasionally acted during later times for in utte ly barbarous tribes tl e women have more po ver in choosing reject ing an l t n n

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tribes of Arctic Am rica repeatedly ran away from h r husband and j ined h r l r and with the Charr as f S Am rica, according to Azara, di rce is quite pt nal. Amo g t th Abipones, man n choosi w f h gains with the parents bo t th price B t t frequ tl h t th g l rescind wl t has be the b me t hides C t \ te

Tierra del F g a g man first obtai u conse t f the pare ts b d g th m som serv ce and th h tt mpts t rry ff tl g l "b t if sh u w ll g h l d h rself in th woods unt l h adm re h art l t red of looking f he and gi p tl p rs t b t this seld m happens I th F j I land th man se ze o th w man wh m h w h for his wif by act al pret nded f rce but reachi g th l m f h abd t h ld sh t ppro f th m t h h ru to som ne ho an protect h lf h w h satisfied th m tt settled f thw th With th Kalm ks th re reg lar ace be t een th b d d brid g oom, th f m ha ing a fai start and Clark was ass red that no in tance occ l g l be ca ght, unl ss h has part lit t th p rs Am gst th wild tribe f th Mala Archi pelag th re lso racing mat h and t ppears from M B account, as Sir J Lubbock remarks, that th ace n t to th swift, tl b ttl t th tro g but t th g man wh l as th good f rtun t pl ase his int nded brid A m l cust m n th th sam re lt pre ails w th th K raks f north r m A

band b t t manif t from many facts gi n b th Re M Shoot th t th ha co

xhib t th ir paces. Th y ha been known to propose to a man, and th y n t rarely run w y w th f red lo er So again, M

Leslie who was intimat ly acquainted with the Kaffirs, says, it i a mi tak to imagine that g rl is sold by he father in the same manne and w tl th same th r ty with wh ch he w ld dispose of a cow Am ng t th d of S Africa, wh n a g l l h n t prob t as w ll as that of the pare Mr W wood Reade mad inquiri s f m w th pect to th n groes f we t rn Africa, and he inf rms me that th women at least m ng th m re int ll g t pag n tribes, l a e h l l ls wh m are q forming tend r pass nate, and faithfu tachm ts. Addit nal cases co ld be gi n.

W thu see th t with sa es th w m n are t n qu t so abject a tat in lat n to m rri g as has oft n been pposed They can t mpt tl m n wh m the prefe and can som tim r ject those wl m th y dislike th r bef re aft ma ri g I ref re ce on the part f the w m n, teadily acti g n any n d recti n, w uld ultim t ly affect the haract f th tribe f the w m n would g n rally hoose n t m rely the l ndsom t m n, accord g t th ir tandard f tast b t th se wh w re at th sam tim be t abl to d f d and ppo t th m. S ch w ll-end wed pairs w uld comm nly rear a larg r n mbe of ff p ing than th les f red Th sam result w uld b ly f ll w in a t ll m re marked mann if th re was selecti n n both id that is, f th m ttract and at the sam t m m pow f l m n w re to p f and w re pref red by th m re tt act e w m n And th d bl f rm of selecti n seems act ally t ha occurred pecially during th arl period f ur l g hi tory

We will now examine a little more closely some of the characters which distinguished the several races of man from one another and from the lower animals namely the greater or less deficiency of h

[illegible] tween the different races as we have seen in the h t [illegible]

[illegible] ave [illegible] out we [illegible] ans of judging whether they have been acted on chiefly from the male or female side The musical faculties of man have likewise been already discussed

Absence of Hair on the Body and its Development on the Face and Head —From the presence of the woolly hair or lanugo on the human fœtus and of rudimentary hairs scattered over the body during maturity we may infer that man is descended from some animal which was born hairy and remained so during life The loss of hair is an inconvenience and probably an injury to man even in a hot climate for he is thus exposed to the scorching of the sun and to sudden chills especially during wet weather As Mr Wallace remarks the natives in all countries are glad to protect their naked backs and [illegible]

[illegible] therefore cannot have been divested of hair through natural selection [2] Nor as shewn in a former chapter have we any evidence that this can be due to the direct action of climate or that it is the result of correlated development

The absence of hair on the body is to a certain extent a secondary sexual character for in all parts of the world women are less hairy than men Therefore we may reasonably suspect that this character has been gained through sexual selection We k[illegible] that th[illegible] faces of several species of monkeys and large surfaces at the posterior end of the body of other species have been denuded of hair and this we may safely attribute to sexual selection for these surfaces are not only vividly coloured but sometimes as with the male mandrill and female rhesus much more vividly in the one sex than in the other especially during the breeding season I am informed by Mr Bartlett that as these animals gradually reach maturity the naked surfaces grow larger compared with the size of their bodies The hair however appears to have been removed not for the sake of nudity but that the colour of the skin may be more fully displayed So again with many birds it appears as if the head and neck had been divested of feathers through sexual selection to exhibit the brightly coloured skin

As the body in woman is less hairy than in man and as this character is common to all races we may conclude that it was our female semi human ancestors who were first divested of hair and that this occurred at an extremely remote period before the several races had diverged from a common stock Whilst our female ancestors were gradually acquiring this new character [illegible]

[illegible] has not been limited either by sex or age There is nothing surprising in a partial loss of hair having been esteemed as an ornament by our ape like progenitors for we have seen that innumerable strange characters have been thus estee[illegible]

[illegible] acquired for we know that this is the case with the plumes of certain birds and with the horns of certain stags

The females of some of the anthropoid apes as stated in a former chapter are somewhat less hairy on the under surface than the males and he[illegible] we have what might have afforded a commencement for the process of denudation With respect to the completion of the process through sexual selection it is well [illegible]

[illegible] to bribe a man to marry the first hairy woman in the family and she trans-

[2] *Contributions to the Theory of Natural Selection* 18[illegible] [illegible] Rev T R Stebbing [illegible] (*Transactions of Devonshire* [illegible] 18[illegible]0) remarks that [illegible] Mr Wallace [illegible]

mitted this character to his young offspring of both sexes.[23]

Sor ... rem ... hm rel airs tl ... tl ers, ... pec ... me ... E ... l ... re n ...

tl ... l s first ... eq ired the r bearus ... l select n as an orn me t, tran m tt g tl m ... m t ase eq lly ... ne ly so to tl ... ff p ng f b tl se ... W kn w from ... l ... tl t with m nk ... l tl f m le as

... al ys pt t ret ... W l ... see tl t ... ts ... re ften ... y l airs and tl y ... j t t re rt ... h ... h ... t rst ... al ... m l t pe It

... p g ... t rs f wl ... botl se ... re beard ... bt probabl ...

... of ... b rd see ... t l ... e been int rited f ... h ... rog ... t ... f ... wl ... tl re is

... be th re lt f re rs ... l ecked by any f rm f select ... t ... t m ... ar b l ty ... than th l m t f tl sa ... ace cease t be remarkabl.[24]

... b rd tl ... tl t f tl f ... l ... t ... f lly de ... l ped ... l ... t m t nt ... j ... t as w tl n ... l

W th re pect t th b ard ... m ... f w tu n t ... ur be t g ... d ... tl Q ad m ua, w fi d be rd ... q ll ... d ... l ped ... b tl se ... f m ... pec ... b t ... so ... tl co fined t tl males, ... m re d ... l ped ... tl ... tl an n th f m l s. From tl ... f t ... d fro ... tl ... n

fact f t g ... t a ab l t ... d ffere t ... ce ar d ... w tl ... tl sam ... ce f r tl ... nd cat ... re rs ... l g l t h act rs bei g ... pt t ... n re-appearance

N m t w ... e look tl pa t wl ... l sexual lect n m y l ... e j l ed in l ter tim ... f w kn ... tl t w tl sa ... tl e m n f tl be rdl ss race tak ... fi t pains n ad t ... g ... rs h ... from tl ... f ce as som th g odio s, wl l t tl m ... f tl ... b rded race feel tl gre t t prid ... tl ... b rds. Th w m ... n d ... l t pa t cipat ... th se feelings, and f so se ... l select n an l rdly l ... f led t l ... ff ted som tl g in tl co rs ... f l t t m s. It ... lso poss bl th t tl ... l g-c t ed l b t f ... ad ... t ... tl h ... m ... l ... p o d ced ... n al ... nt d ffect D ... Bro n-Seq ard has sl ... tl t f certain ai mals ... re pe t d ... p rt ... l ... mai ... th ... ff p g ... re ff ted l ... tl ... d ... co ld b g ... f tl ... l ... t ... ce f tl ... ffect ... f m t l t ... b t ... f ... t l t l ... asce tained by M. Sal n[25]

... charact ... f ... h ... ea ly pe l k proge itors. ... Il rdly ... ad ... eed ... thus ... k has ... t th ... m ... t l ... f ... (s ... f ... t ... e pe gel, D Fortsch ... ted D ... m ... l ... p 60) ... th bo ... j l ... t ... f th loss of ha ... m ... k d through se ual selec ... b t no ... of th ... pposed argume ts seem t ... f ... h ... ght, co pa so ... h the f ... h ... g that tl ... ud ty of th ... l a ... ts ... t ... cert ... t ... t ... seco dary se ual har act ... ma and ... som f the Quadrumana.

[24] Ube d R ht ... g d Haare m M ... schl h Korpe ... Mülle ... A h ... f ... A at ... nd Phys. 1837 s. 40

[25] O th ... tad f thers ... f Mom ts, Proceed ... g ... f the Zoological Society 18 3, p. 429

We will now examine a little more closely some of the characters which distinguished the several races of man from one another and from the lower animals namely the greater or less deficiency of hair on the body and the colour of the skin We need say nothing about t t di ersity in the shape of the features

been acted on through sexual selection but we have no means of jud ing whether they have been acted on chiefly from the male or female side The musical faculties of man have likewise been already discussed

Absence of Hair on the Body and its Development on the Face and Head —From the presence of the woolly hair or lanugo on the human fœtus and of rudimentary hairs scattered over the body during maturity we may infer that man is descended from some animal which was born hairy and remained so during l an inconvenience and

wet weather As Mr Wallace natives in all countries are glad to protect their naked backs and shoulders with some slight covering No one supposes that the nakedness of the skin is any direct advantage to man his body therefore cannot have been divested of hair through natural selection[21] Nor as shewn in a former chapter have we any evidence that this can be due to the direct action of climate or that it is the result of correlated development

The absence of hair on the body is to a certain extent a secondary sexual character for in all parts of the world women are less hairy than men Therefore we may reasonably suspect that this character has been gained through sexual selection We know that the faces of eral speci of monkeys and large surfaces at the posterior end of the body of other species have been denuded of hair and this we may safely attribute to sexual selection for these surfaces are not only vividly coloured but sometime as with the male mandrill and female rhesus much more vividly in the one sex than in the other e pecially during the breeding season I am informed by Mr Bartlett that as these animals gradually reach maturity the naked surfaces grow larger compared with the ize of their bodies The hair however appears to have been removed not for the ake of nudity but that the colour of the kin may be more fully displayed So rs as if the

As the body in woman is le s ha ry man and as this character is common to all races e may conclude that it was our female semi human ancestors who were fir t dive ted of hair and that this occurred at an extremely remote period before the sev ral races had diverged from a common stock Whilst our female ancestors were gradually acquiring this new character of nudity they must have transmitted it almost equally to their off pring l lst young so that its trans

sex or age There is nothing surp partial loss of hair ha ing been e teemed as an ornament by our ape like progenitor for we have seen that innum erable strange characters have been thus esteemed by animals of all kinds and have consequently been gained through sexual selection Nor is it surprising that a slightly injurious character should have been thus acquired for we know that this is the case with the plumes of certain birds and with the horns of certain stags

The females of some of the anthropoid apes as stat d in a former chapter are somewhat rface than the males

With e pect to the compl o through sexual selection it ll to bear in mind the New Zealand prov rb There is no woman for a hairy man All ho have seen photographs of the Siam se hairy family will admit how ludicrously hideous is the opposite extreme of excessive hairine s And the King of Siam had to bribe a man to marry the first hairy woman in the family and she trans-

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usual
skin he might h v s
ti n thr ugh ts up or be uty r the he lth t
taching to super or cleanl ness

females were modified in th r respects fo the same purpose and by the same m ans so that women have acquired sweet r v ces and become more beautiful than men.

It deserves ttention that with mankind th conditions were in many respects much m re favourable for sexual selection during a v ry early period, when man had nly just attained to the rank of manhood, than during later times. For h w uld then, as we may safely conclude, ha been guided more b his in stinctive passions, and less by f resight or reason. H w uld ha j alously guarded his wif or wi es. H w uld n t ha practised in fanticide nor val ed his wi m rely as useful slaves nor ha e been betrothed to th m during infancy Hence we may inf th t th races of men were differentiated, as far as sexual selection is concerned, in chief part at a very remote epoch and this conclusi n throws light on th remarkabl fact that t th most ancient period, of which w ha e not as y t an record, the races of man had already come to differ nearly or quit as much as th y do at the present day

The views here advanced n the part which sexual selection has pla ed in th history of man, want scientific precisi n. H wh does not admit this ag ncy in th case of the low animals, will disregard all that I ha e written n th lat chapters on man We cannot positi ely say that this character but n t that, has been thus modified it has l ow v r been sh wn that th races f man diff r from ach th r and from th ir nearest allies, in certain characters which are f no service to th m in th ir daily hab ts f life, and whi h t is trem ly probabl w uld hav been mod fied thro gh sexual selection. We ha e seen that with th lowest sa ages the people of ach tribe admire thei own characteristic qualities,—th shape f th head and face the squareness of th cheek-bones, the prom inence o d pression of the nose the col ur of the skin, th len th of th hair on the head the absence of hair on th face and bod o the presence of a gre t beard, and so forth. H nce these and th r uch points could hardl fail t be slowly and gradually exaggerated from the m re powerful and abl men in ach tribe who w uld ucceed in rearing th largest num ber of off pring, having selected durin many g n rati ns f r th ir w es th most trongly characterised and th refore most attracti w men. For my wn part I conclud that f all the causes which have led to the differences in ext rnal ppearance between the races of man, and to a certain extent between man and th lower animals, sexual selection has been th mo t efficient.

has a more direct be ...

... aturally somewhat reduced[27] Nevertheless with mankind the habit of eradicating the beard and the hairs on the body would probably not have arisen until these had already become by some means reduced

It is difficult to form any judgment as to how the hair on the head became developed to its present great length in many races Eschricht[28] states that in the human fœtus the hair on the face during the fifth month is longer than that on the head and this indicates that our semi human progenitors were not furnished with long tresses which must therefore have been a late acquisition This is likewise indicated by the extraordinary difference in the length of the hair in the different races in the negro the hair forms a mere curly mat with us it is of great length and with the American natives it not rarely reaches to the ground Some species of Semnopithecus have their heads covered with moderately long hair and this probably serves as an ornament and was acquired through sexual selection The same view may perhaps be extended to mankind for we know that long tresses are now and were formerly much admired as may be observed in the works of almost every poet St Paul says if a woman have long hair it is a glory to her and we have seen that in North America a chief was elected solely from the length of his hair

Colour of the Skin —The best kind of evidence that in man the colour of the skin has been modified through sexual selection is scanty for in most races the sexes do not differ in this respect and only slightly as we have seen in others We know however from the many facts already given that the colour of the skin is regarded by the men of all races as a highly important element in their beauty so that it is a character which would be likely to have been modified through selection as has occurred in innumerable instances with the lower animals It seem at first sight a monstrous supposition that the jet blackness of the negro should have been gain d thro gh ... sexual selection but this view is supported by various analogies and we know that negroes admire their own colour With mammals when the sexes differ in colour the male is often black or much darker than the female and it depends merely on the form of inheritance whether this or any other tint is transmitted to both sexes or to one alone The resemblance to a negro in miniature of *Pithecia satanas* with his jet black skin white rolling eyeballs and hair parted on the top of the head is almost ludicrous

The colour of the face differs much more widely in the various kinds of monkeys than it does in the races of man and we have some reason to believe that the red blue orange almost white and black tints of their skin even when common to both sexes as well as the bright colours of their fur and the ornamental tufts about the head have all been acquired through sexual selection As the order of development during growth generally indicates the order in which the characters of a species have been dev ...

... as much in colour as do the adults although their bodies are as completely destitute of hair we have some slight evidence that the tints of the different races were acquired at a period subsequent to the removal of the hair which must have occurred at a very early period in the history of man

Summary —We may conclude that the greater size strength courage pugnacity and energy of man in comparison with woman were acquired during primeval times and have subsequently been augmented chiefly through the contests of rival males for the possession of the females The greater intellectual vigour and power of invention in man is probably due to natural selection combined with the inherited effects of habit for the most able men will have succeeded best in defending and providing for themselves and for their wive and offspring As far as the ...

... o charm or excite the opposite sex and transmitted them only to their male offspring The females apparently first had their bodies denuded of hair also as a sexual ornament but they transmitted this character almost equally to both sexes It is not improbable that the

... skull t d to b nh ted

[28] *Über die Richtung* &c s 40

cannot be accounted f by any f rm of selec tion, or by th inherited ffects f th use and disuse of parts. W kn w howe er th t man strange and trongly marked peculiarities of structure occasionall ppear in our d mest cated productions, and if their unkn wn causes ere to act more nif rmly th y w ld probably becom comm to all the ndi iduals f the species. We may hope h reaft t under stand som thing abo t th cause f u h occa onal modifications, especially through th stud of monstrositi h nce th labours of experimentalists such as those f M Camille Dareste, are full of promise f r th f t In general w can nly sa that th cause f ach ight ariation and f ach m nstro ty l es much more in the con titut n of th rganism, than in the n ture of th surrounding cond tions th gh new and ha ged cond t ns certainly pla an mportant part in xciting organic chan f man kinds.

Thro gh th m ans just pecified aided perhap by th rs as t und sco red man has bee raised to his prese t tat B t since he ttained to th rank of manhood h has d rged into d ti ct races, as th may be more fitly called, sub-species. Som of these such as th N gro and European, are so distinct that, if specim ns had been bro ght t f rmat n,

h t h se can be accounted ou

It must no be pos

of ach race from th th races, and f all from commo tock, can be t aced back t an pai of prog nitors. On th co trary at rs tag in th process f modificati n, all th nd id als whi h w re in an w bet te fitted f th ir cond ti ns of lif tho gh in diff re t degrees, w ld ha urv ed in greater umbers than th l ss w ll fitted Th process w uld ha bee lik that f ll wed by man, wh h doe not intentionally select particular ndi iduals, b t breeds from all th perior ind iduals, and neglects th inf ri ll thus lowl but urely modifi his tock, and unconsciousl f rms a w train. So with respect to modificati ns acquired ind pendently of selection, and d t ariations arising from the ature of th organism and th acti n

f th rrounding cond ti ns or from changed hab ts of life no single pair will ha e been modified much more than the th r pairs in hab ting th same co ntry for ll will ha e been continually bl nded thro gh free intercrossing

By consid ring the mbryological tructure of man,—the h mol gies which he presents w th th low r animals,—th rud m nts wh ch h retains,—and the re ers ns to whi h he is liable we can partly recall n maginat n the form r conditi n of our early p og nit rs and can appro im t ly place th m in th r proper place in th zool gical seri s. We thus learn th t man is desce ded from a hairy tailed quadruped, probabl arboreal n its hab ts, and an inhab tant of th Old W ld This creature if ts wh l structure had been examined by natural t, would ha e been classed am ngst th Quadrumana, as urely as th till m re anci nt pro nito of the Old and N w W ld m nk s. Th Quadrumana and ll th high r mammals are probably deri ed from an anci nt marsup al animal and this through lo g series f d rsified f rms from some amphib an like reature and thi a ain from som fish like animal. In the dim ol scur t f th past w can see th t the early prog nito f all th V rtel ta m st ha be n an aq tic animal provided w th bran hiæ with th tw se es united n th sam nd d ual, and w th the m t mportant rgans f th body (ch as th brain and heart) mpe fectly o not t all de loped This animal seem to ha been m re l ke th larvæ of th xi t ng marin ascidians than any th r kn wn f rm.

Th high standard f ur intellectual po rs and m ral disposit is th gre t t difficulty which presents tself afte w ha been dri n to this co clus n n the rigin of man. But rv wh admits th prin pl of lu ti n, must see that th m ntal pow rs of th high animals, which are th *same in kind* w th those of man, th gh so diff rent n degree, are capabl f ad ancem nt. Th u th interval between th m ntal pow rs of n f th high pe and of fish, o between those of an ant and scal insect, is imm nse y t their d elopm nt does not off an pecial difficulty f with o r d mesticated an mals, th m ntal faculti are certainly variable and th ariati ns are inh rited. No on d ubts that th are of th utm t importance to animals in tat f nature. Th ref re th condi ti ns are f ourabl for th ir d elopment

CHAPTER XXI

GENERAL SUMMARY AND CONCLUSION

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advanced are highly speculative and some no doubt will prove erroneous but I have in every case given the reasons which have led me to one view rather than to another It seemed worth while to try how far the principle of evolution
more co
of man
progress
but false
do little harm for every one takes a salutary pleasure in proving their falseness and when this is done one path toward error is closed and the road to truth is often at the same time opened

The main conclusion here arrived at, and now held by many naturalists who are well competent to form a sound judgment is that *man is descended from some less highly organ i ed form* The grounds upon which this con clusion rests will never be shaken for the close similarity between man and the lower animals in embryonic development as well as in in numerable points of structure and constitu tion both of high and of the most trifling im portance—the rudiments which he retains and the abnormal reversion to which he is occasionally liable—are facts which cannot be disputed They have long been known but un til recently they told us nothing with respect to the origin of man Now when viewed by the light of our knowledge of the whole organic world their meaning is unmistakable The great principle of evolution stands up clear and firm when these groups or facts are considered in connection ith others such as the mutual affinities of the membe s of the same g oup their geographical distribution in past and present times and their geological succession It is incredible that all these facts should speak falsely He who is not content to look like a savage at the phenomena of nature as disconnected cannot any longer believe that man is the work of a separate act of creation He will be forced to admit that the clo e re semblance of the embryo of man to that for instance of a dog—the construction of his skull limbs and whole frame on the same plan with that of other mammals independently of the uses to which the parts may be put—the occasional re appearance of various structures, for instance of several muscles which man does not normally possess but which are common to the Quadrumana—and a crowd of analogous facts—all point in the plainest manner to the conclu ion that man is the co descendant with other mammals of a common progenitor

We have seen that man incessantly pre ents individual differences in all parts of his body and in his mental faculties These differences or variations seem to be induced by the same general causes and to obey the same laws as with the lower animals In both cases similar laws of inheritance prevail Man tends to in crease at a greater rate than his means of sub sistence consequently he is occasionally sub jected to a severe struggle for existence and natural selection will have effected whatever lies within its scope A succession of strongly marked variations of a similar nature is by no means re quisite slight fluctuating differences in the individual suffice for the worl of natural election not that we have any reason to sup pose that in the same species all parts of the organisation tend to vary to the same degree We may feel assured that the inherited effects of the long continued use or disuse of parts will have done much in the same direction with natural selection Modifications formerly of importance though no longer of any pecial use are long inherited When one part is modi fied other parts chan e through the principle of correlation of which we ha e instances in many curious cases of correlated mon tro i ties Something may be attributed to the ... n ... m of the surrounding con

siderable importance have been ga ... sexual selection

No doubt man as well as every other ani mal presents structures which eem to our limited knowledge not to be no v of a y serv ice to him nor to ha e been so fo m rly either for the general conditions of life or in the rela tions of one sex to the other Such tructures

scope of public pinion, and receiv praise and their pposites blame But with th l ss ci l ised nations reason often rrs, and many bad customs and base superstitions com within the same scope, and are th n esteemed as high virtues, and their breach as h a y crimes.

The moral faculties are g rall and ju tly esteemed as of high al e than the t llec tual powers. B t w sh ld bear in mind that the activity of th mind in vi idly recalling past impressi ns is on of the fundamental though secondary base of conscience Thi ssord th strongest argum nt f r educati g and stimulating in all possibl wa s tl e int l lectual faculties of rv human be ng N doubt man with torp d mind f his social affections and ympathies are w ll d l ped will be led t good acti ns, and m h a fairl sensiti e consci nce But what e renders the imaginati n m re vi id and strength ens the hab t of recalling and comparing past impressions, will mak th consci nce m re sensitive and ma som wh t compensat for weak social affections and ympathies.

The moral nature of man has reached t prese t standard, partly thro gh tl ad ancement t of his reasoning pow rs and co seq ntly of j st public pini n, but especiall from his sympathi h ing been rend red m re t nde and wid l diffused thro gh th ffects of hab t, exampl n, tru ti n, and reflect n. It is not improbabl that aft l ng practice virtuous tend nc ma be inh rited. W th the more ci lised races, th co ti n f th existence of an all seeing D t has had po-

w escape tin m — actions, co trolled b reaso aff rd l im th safest rul His consci ce th n becom th supreme judge and monit N rtl less th first f und ti rigin of tl m ral sense lies in the social in tincts, includi mpatl and these instin ts doubt w re primaril gained, as in tl case of th l animals, through natural selecti n.

The bel ef in God has oft bee ad anced as not l th gre test, b t th most compl te of all the distinctions between man and th lo animals. It is how impossibl as w ha seen, t mai tai that this belief is innat or instincti in man. On the the hand belief all perv adi g pirit al ag ncies seems to be uni rsal and ppare tly follo from

been seu j — His xi t nce But this s rash argum ... s w sh uld thus be compelled to bel e in tl exist nce f man, cru l and mal gnant sp rits, only a l ttl m re powe ful than man f r the beli f in th m i far m re gen ral than in a beneficent D ty Th de of a univ rsal and ben ficent Creat r does n t seem to arise n th m l of man until he has been l ted b

from som ask h w does th s bear n the beli f in u m m rtalit of the soul. The barbarous race of man, as S J Lubbock has sh wn, possess no cl ar beli f of thi kind b t argum nts de ri ed from th prim l beli fs f sa ag s are as w h just seen f l ttl o no a ail F w persons feel an anxi ty from the imposs b l ty of d t rmining t what precise period in tl e d lopm nt f th ind dual, from th first trace of a min t g rminal si l man becomes an imm rt l being and there i no re te cause f anx t bec use th period cannot possibly b d termined n tl e graduall r rr seal

is bou d t sh w why t is m re u explain th rigin of man as a di tin t pecies b d sce t from som l f rm thro gl tl l w of ari ti n and natural select n than t explain the birth of tl nd dual tl ro gl th law of rdinary reproducti n. Th b rtl both of th pec es and f th nd d al are equally part l th t grand sequence of nts, whi h mind ref se t accept as th re ult f blind chance Th u d rstanding re lts t ch con l n, wh tl o n t w are bl to beli th t ry l ght aration f tru ture,—th uni n f ach pair n marri g — th dissemin ti n of ach seed —and th ch ts, ha all been rdai ed f som special purpose.

S l selecti n has been treated t great

*The R J A. Pict g es discussi t this ffect in his *New Theorie nd the Old F ith*, 1870.

through natural selection The same conclusion may be extended to man the intellect must have been all important to him even at a very remote period as enabling him to invent and use language to make weapons tools traps &c whereby with the aid of his social habits he long ago became the most dominant of all living creatures

A great stride in the development of the intellect will have followed as soon as the half art and half instinct of language came into use for the continued use of language will have reacted on the brain and produced an inherited effect and this again will have reacted on the improvement of language As Mr Chauncey Wright[1] has well remarked the largeness of the brain in man relatively to his body compared with the lower animals may be attributed in chief part to the early use of some simple form of language —that wonderful engine which affixes signs to all sorts of objects and qualities and excites trains of thought which would never arise from the mere impression of the senses or if they did arise could not be followed out The higher intellectual powers of man such as those of ratiocination abstraction self-consciousness &c probably follow from the continued improvement and exercise of the other mental faculties

The development of the moral qualities is a more interesting problem The foundation lies in the social instincts including under this term the family ties These instincts are highly complex and in the case of tl [illegible] s

[illegible] the distinct emotion of sympathy Animals endowed with the social instincts take pleasure in one another s company warn one another of danger defend and aid one another in many ways These instincts do not extend to all the individuals of the species but only to those of the same community As they are highly beneficial to the species they have in all probability been acquired through natural selection

A moral being is one who is capable of reflecting on his past actions and their motives —of approving of some and disapproving of others and the fact that man is the one being who certainly deserves this designation is the greatest of all distinctions between him and the lower animals But in the fourth chapter I have endeavoured to shew that the moral sense follows firstly from the enduring and ever present nature of the social i [illegible]

[illegible] ng to this condition of mind man cannot avoid looking both backwards and forwards and comparing past impressions Hence after some temporary desire or passion has mastered his social instincts he reflects and compares the now weakened impression of such past impulses with the ever present social instincts and he then feels that sense of dissatisfaction which all unsatisfied instincts leave behind them he therefore resolves to act differently for the future —and this is conscience Any instinct permanently stronger or more enduring than another gives rise to a feeling which we express by saying that it ought to be obeyed A pointer dog if able to reflect on his past conduct would say to himself I ought (as indeed we say of him) to have pointed at that hare and not have yielded to the passing temptation of hunting it

Social animals are impelled partly by a wish to aid the members of their community in a general manner but more commonly to perform certain definite actions Man is impelled by the same general wish to aid his fellows but has few or no special instincts He differs also from the lower animals in the power of expressing his desires by words which thus become a guide to the aid required and bestowed The motive to give aid is likewise much modified in man it no longer consists solely of a blind instinctive impulse but is much influenced by the praise or blame of his fellows The appreciation and the bestowal of praise and blame both rest on sympathy and this emotion as we have seen is one of the most important elements of the social instincts Sympathy though gained as an instinct is also much strengthened by exercise or habit As all men desire their own happiness praise or blame is bestowed on actions and motives according as [illegible]

[illegible] standard of right and wrong As the reasoning powers advance and experience is gained the remoter effects of certain lines of conduct on the character of the individual and on the general good are perceived and then the self regarding virtues come within the

[1] On the Limits of Natural Selection in the *North American Review* Oct. 1870 p 295

duction. In inn m rable instance these char acters are fully de l ped only t m tu tv and often d in g ly part f th ear wh ch is alw s the breeding seaso Th mal s (passing er f w except nal ase) are the more acti e i co rtsh p tl y re th l tt r armed, and are rend red th more ttract e m an us ways. It is to be e. pecı lly bserved that the male d splav tl ir ttractı with th presence f th femal s

pre rence

sex.

B ar g mınd th se facts, and tl marked results f man unconsc select n wh n ppl ed t d m t cated animal and cult ted plants, t seems to me alm t ce ta n that if the ind ıduals f n sex w re d ring l g series of g t ns t p f pairing with certain ind d ls f th th se charact ısed in som peculiar man th ff pring ould sl wly b t urely becom modified n this sam m nn I ha n t tt mpted to conce l that, cept g wl th males are mo m rous than th f m l s, wh n polygamy pre ails, t d btf l h w th m re tt act males ceeed ın lea ng larg umbe of ff prı g t nl rit tl peri rity in ornament tl harms than th less ttractı mal b t I h sh wn th t this ld probabl f llow from th f m les,— especıall th m re goro o s, wl l w uld be th first t breed,— pref rring n t nl tl more att actı b t t tl sam tım th m re g ro and t n mal

Alth l l som po t d ce that th f males of man l rd nd som mam mals hould be l wed w tl fficient ta t t pprec t rnam ts, h h w ha reaso to ttrib t t se al select and thu is m re asto l g th ase f rept les, fish, and nsects B t w really kn w little about th m nd f th low an m ls. It an t be pposed f nstance that mal b rds of parad se peacocks l ld tak ch pains rect g, pread g and brating th ir be tıful plum bef re th f males fo

purpose We b uld remember the fact gı en n cell t authority n a form r chapter that se e al peahens, when debarred fr n an admured n al remained wid ws du ing a whole season r tl r than pair w th an the b rd

Ne ertl less I kı w of n fact n nat ral hist ry more w derful than th t tl e f mal A gu pheasant sh uld ppreciate tl e ex quis te sl ad ng of th ball and sock t rn m nts and tl l gant patt rns on th w ng f ath rs f tl e m l He who tl nks that tl e mal was re ted as h now xists mu t admit that th gre t pl m s, wh ch pre ent the wı g from be g used f fl ght, and wl ch are displ yed d ring court h p d at ı o othe tım t pecul a to th e

pecı so h cre t prec con ct n that th mal Argus ph asant ac l beauty grad ally thro gh th pref

been ad anced thro gh x rcise or hab t, ju t as wn tast gradually ımpro ed In th m le thro gl th f rtu ate cl ance of a f w feath rs be ng l ft unchanged we can d s- tın tl trace h w simpl pot w th l ttl f l ous had ng n n d may ha been d l ped b mall t p ınt the w derful b ll d sock t rnam nts a d t s probabl t

could ıa th b ty f tl mal s, and which g n ally coinc d w th wn tandard h uld flect th t th rv -cells f th braı in the h ghest w ll as in th l west m mbers f the rt

sam d gree

Th read wh l as tak n th tro bl to g through th se al ch pt rs de ted t se u l selecti n, will b abl to j dg h w far th co cl n t which I ha arri ed are ppo ted by uffici t d ce If he accepts these con clusions h ma I think, safely extend th m to mankind b t t w uld be s pe flu us he

much remains doubtful but I have endeavoured to give a fair view of the whole case In the lower divisions of the animal kingdom sexual selection seems to have done nothing such animals are often affixed for life to the same spot or have the sexes combined in the same individual or what is still more important their perceptive and intellectual faculties are not sufficiently advanced to allow of the feelings of love and jealousy or of the exertion of choice When however we come to the Arthropoda and Vertebrata even to the lowest classes in these two great sub kingdoms sexual selection has effected much

In the several great classes of the animal kingdom —in mammals birds reptiles fishes insects and even crustaceans —the differences between the sexes follow nearl th

nghting with their rivals They are generally stronger and
endowed with
age and pugn
exclusively or in a much higher degree than the females with organs for vocal or instrumental music and with odoriferous glands They are ornamental with infinitely diversified appendages and with the most brilliant or conspicuous colour often arranged in elegant patterns whilst the females are unadorned When the sexes differ in more important structures

only part of the year namely the breeding season They have in many cases been more or less transferred to the females and in the latter case they often appear in her as mere rudiments They are lost or never gained by the males after emasculation Generally they are not developed in the male during early youth but appear a short time before the age for reproduction Hence in most cases the young of both sexes resemble each other and the female somewhat resembles her young offspring throughout life In almost every great class a few anomalous cases occur where there has been an almost complete transposition of the characters proper to the two sexes the females assuming characters which properly belong to the males This surprising uniformity in the laws regulating the differences between the sexes in so many and such widely separated classes is intelligible if we admit the action of one common cause namely sexual selection

Sexual selection depends on the succes

of the same sex generally the males in order to drive away or kill their rivals the female remaining passive whilst in the other the struggle is likewise between the individuals of the same sex in order to excite or charm those of the opposite sex generally the females, which no longer remain passive but select the more agreeable partners This latter kind of selection is closely analogous to that which man unintentionally yet effectually brings to

modify the breed

The laws of inheritance determine whether characters gained through sexual selection by either sex shall be transmitted to the same sex or to both as well as the age at which they shall be developed It appears that variations arising late in life are commonly transmitted to one and the same sex Variability is the necessary basis for the action of selection and is wholly independent of it It follows from this, that variations of the same general nature have often been taken advantage of and accumulated through sexual selection in relation to the propagation of the species as well as through natural selection in relation to the general purposes of life Hence secondary sexual

The modifications acquired through sexual selection are often so strongly pronounced that the two sexes have frequently been ranked as distinct species or even as distinct genera Such strongly marked differences must be in some manner highly important and we know that they have been acquired in some instances at the cost not only of inconvenience but of exposure to actual danger

The belief in the power of sexual selection rests chiefly on the following considerations. Certain characters are confined to one sex and this alone renders it probable that in most cases they are connected with the act of repro-

l h ld l aboo n ho d scend

at ha ing se

ex rtio s, t tl rs mm t f th gan scale and th fact f h h ng thu risen stead f h g bee bongin lly placed th re may gi e him hope f r till high r d ti y in th d stant fut re B t we are not h re concerned with h pes or fea s, only with tl e tr th as far as ur reason pe mits us to disco er t

d I h e gi en the e id nce to th best f my ab lity We m st l wev r acknowledge as t seems to me that man with all his noble qual t e w th ymp tl y wh ch feels f the m t d based with bene olence which e tends not nly to otl r men but to the humbl t l g cre ture with hi god like int llect wh h l as pen trated nto the moveme ts and con stituti n f the solar system—with all tl se xalted pow rs—Man still bears in his bod ly f ame the nd l ble stamp of his lowly origin

to repeat what I have so lately said on the manner in which sexual selection apparently has acted on man both on the male and female side causing the two sexes to differ in body and mind and the several races to differ from each other in various characters as well as from their ancient and lowly organised progenitors

He who admits the principle of sexual selection will be led to the remarkable conclusion that the nervous system

various bodily structures and of certain mental qualities Courage pugnacity perseverance strength and size of body weapons of all kinds musical organs both vocal and instrumental bright colours and ornamental appendages have all been indirectly gained by the one sex or the other through the exertion of choice the influence of love and jealousy and the appreciation of the beautiful in sound colour or form and these powers of the mind manifestly depend on the development of the brain

Man scans with scrupulous care the character and pedigree of his horses cattle and dogs before he matches them but when he comes to his own marriage he rarely or never takes any such care He is impelled by nearly the same motives as the lower animals when they are left to their own free choice though he is in so far superior to them that he highly values mental charms and virtues On the other hand he is strongly attracted by mere wealth or rank Yet he might by selection do something not only for the bodily constitution and frame of his offspring but for their intellectual and moral qualities Both sexes ought to refrain from marriage if they are in

de pes ully or

known Everyone does good service who aids towards this end When the principles of breeding and inheritance are better understood we shall not hear ignorant members of our legislature rejecting with scorn a plan for ascertaining whether or not consanguineous marriages are injurious to man

The advancement of the welfare of mankind is a most intricate problem all ought to refrain from marriage who cannot avoid abject poverty for their children for poverty is not only a great evil but tends to its own increase by leading to recklessness in marriage On the other hand as Mr Galton has remarked if the prudent avoid marriage whilst the reckless marry the inf

er it ct to into not the ase

leading to man

should not be prevented by laws or customs from succeeding best and rearing the largest number of offspring Important as the struggle for existence has been and even still is yet as far as the highest part of man's nature is concerned there are other agencies more important For the moral qualities are advanced either directly or indirectly much more through the effects of habit the reasoning powers instruction

which afforded the basis for the development of the moral sense

The main conclusion arrived at in this work namely that man is descended from some lowly organised form will I regret to think be highly distasteful to many But there can hardly be a doubt that we are descended from barbarians The astonishment which I felt on first seeing a party of Fuegians on a wild and broken shore will never be forgotten by me for the reflection at once rushed into my mind —such were our ancestors These men were absolutely naked and bedaubed with paint, their long hair was tangled their mouths frothed with excitement and their expression was wild startled and distrustful They possessed hardly any art and like wild animals lived on what they could catch they had no government and were merciless to every one not of their own small tribe He who has seen a savage in his native land will not feel much shame if forced to acknowledge that the blood of some more humble c

pans to make their d splay fully and if mad before two observ rs, they turn t him wh seems to pay the most attenti n.

With respect to th origin of th hab t, von Fische remarks th t his m nk ys like to ha their naked hind r end patted stroked and that they th grunt w th pl as re Th y ft n also turn this part of th r bodies to oth r monkeys to ha b ts f dirt p ked ff nd so no doubt t w uld be with respect to th rns. But the hab t with ad lt animals is connected t certain exte t with sexual feelings, f von Fischer wat hed thro gh glass door a f male *Cynopithecus ger* and sh d ring se eral days, *mdr hte nd dem M chen mit gurgeinden Tonen d st l g othet Sit flach ..., was ich f uher n d e..em Th er bemerkt hatte Beim l bl k d es C gen standes rregte sich das M nchen htl h dena poltert heft g den St ben benfalls gurgelnde Laute usstossend* As all tl m n k rs which l e th hind r part f th ir

I should ha th ght that th re was no need for the se es t recognise ach otl t a distance. It seems t m more probabl th t th bright colo rs, wh th on th face hind end, as in th mandrill both serv as a

should ha bee this part of th bod es hich has bee m re less deco ted Th fact that t is nly th monk thus charact ised hich, as far as t prese t kn wn, act in this mann as greet g t wards th m le rend rs t d btf l wl th th hab t was first acquired from som ind pend t cause, and that aft rward th parts in q esti w re coloured as se al rnam t wh th th colouring and th hab t of t rning round w re first acquired thro gh ar t n and sexual selection, and that aft rw rd th hab t was re tained as gn f pl as re as a greeting, thro gh th principl of inh rited associ tion. This princ ple ppare tl comes t pla many occasi ns thus t is generally admitted that th so gs of b rd serv mainl as an t tractio d ri g th seaso f l and that th lel or great co gregations of th black grouse are connected w th th ir courtship b t

tl e h b t f nging has been retained b some birds wl n th y feel happy for nstance by the comm n rob n, and the hab t of congreg t g has been retained by th black grouse during oth r seasons of the year

I beg l ave to refe to one othe po t in re latio to sexual select on. It has been ob ected that this f rm of select n, as far as the orna m nt f th males are concerned impl s that all f mal s w thin th sam district m t possess and ercise actly the sam taste It should h w r be observed in the first place that altl h the ran of ariat n of a speci may be ry larg t is by no m ans ind finite I h e elsewh re gi n a good in tance of tl fact n the p geon of wh ch th re are t l ast a hundred ari ti s differing widely in th r colours, and t least a score f ari ties of th f wl diff ring in the sam kind f w y b t th rang f col n these two peci s s xtrem ly di ti t. Th refore th f males f natural peci cann t h e an unlimited scope fo th taste In th second place I presume tl ... f sexual

mire n which h be uty d pends. n ma m drill has n t nly th hind end of h

th indi dual in an th w y Th m les wh h w re th handsomest o th mo t t tracti in any mann t th f males w ld pair oft nest, and w uld lea th m re off spring than oth males. Th ff pring f th f rm alth gh ar usly int rcrossed w uld th nherit th peculiariti of th ir f th rs tran mit an creased t d ncy to vary in th sam man Conseq ntly th wh l body f mal inhab ting th sam country w ld t d from the ffects of constant int rossing t becom modified almo t unif rmly b t som times littl m re in ne characte and som times in an th th gh at an trem ly slow rate all ultimately being thus

SUPPLEMENTAL NOTE

ON SEXUAL SELECTION IN RELATION TO MONKEYS

Reprinted from NATURE *November*, *1876 page 18*

In the discussion on Sexual Selection in my *Descent of Man* no case interested and perplexed me so much as the brightly-coloured hinder ends and adjoining parts of certain monkeys As these parts are more brightly coloured in one sex than the other and as they become more brilliant during the season of love I concluded that the colours had been gained as a sexual attraction I was well aware that I thus laid myself open to ridicule though in fact it is not more surprising that a monkey should display his bright red hinder end than that a peacock should display his magnificent tail I had however at that time no evidence of monkeys exhibiting this part of their bodies during their courtship and such display in the case of birds affords the best evidence that the ornaments of the males are of service to them by attracting or exciting the females I have lately read an article by Joh von Fischer of Gotha published in *Der Zoologische Garten* April 1876 on the expression of monkeys under various emotions which is well worthy of study by any one interested in the subject and which shews that the author is a careful and acute observer In this article there is an account of the behaviour of a young male mandrill when he first beheld himself in a looking glass and it is added that after a time he turned round and presented his red hinder end to the glass Accordingly I wrote to Herr J von Fischer to ask what he supposed was the meaning of this strange action and he has sent me two long letters full of new and curious details which will I hope be hereafter published He says that he was himself at first perplexed by the above action and was thus led carefully to observe several individuals of various other species of monkeys, which he has long kept in his house He finds that not only the mandrill (*Cynocephalus mormon*) but the drill (*C leucophæus*) and three other kinds of baboons (*C hamadryas sphinx* and *babouin*) also *Cynopithecus niger* and *Macacus rhesus* and *nemestrinus* turn this part of their bodies, which in all these species is more or less brightly coloured to him when they are pleased and to other persons as a sort of greeting He took pains to cure a *Macacus rhesus* which he had kept for five years of this indecorous habit and at last succeeded These monkeys are particularly apt to act in this manner grinning at the same time when first introduced to a new monkey but often also to their old monkey friends and after this mutual display they begin to play together The young mandrill ceased spontaneously after a time to act in this manner towards his master von Fischer but continued to do so towards persons who were strangers and to new monkeys A young *Cynopithecus niger* never acted excepting on one occasion in this way towards his master but frequently towards strangers, and continues to do so up to the present time From these facts von Fischer concludes that the monkeys which behaved in this manner before a looking glass (viz the mandrill drill *Cynopithecus niger Macacus rhesus* and *nemestrinus*) acted as if their reflection were a new acquaintance The mandrill and drill which have their hinder ends especially ornamented display it even whilst quite young more frequently and more ostentatiously than do the other kinds. Next in order comes *Cynocephalus hamadryas* whilst the other species act in this manner seldomer The individuals however of the same species vary in this respect and some which were very shy never displayed their hinder ends It deserves especial attention that von Fischer has never seen any species purposely exhibit the hinder part of its body if not at all coloured This remark applies to many individuals of *Macacus cynomolgus* and *Cercocebus radiatus* (which is closely allied to *M rhesus*) to three species of Cercopithecus and several American monkeys. The habit of turning the hinder ends as a greeting to an old friend or new acquaintance which seems to us so odd is not really more so than the habits of many savages, for instance that of rubbing their bellies with their hands or rubbing noses together The habit with the mandrill and drill seems to be instinctive or inherited as it was followed by very young animals but it is modified or guided like so many other instincts, by observation for von Fischer says that they take

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rendered more attractive to the females The process is like that which I have called unconscious selection by man and of which I have given several instances In one country the inhabitants value a fleet or light dog or horse and in another country a l

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l. u to nave been mo lified in the desired manner almost uniformly thou.h differently in each country In two absolutely distinct countries inhabited by the same species the individuals of which can never during long ages have intermigrated and intercrossed and where moreover the variations will probably not have been identically the same sexual selection might cause the mal + d a s

it

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a u nerent tastes with re pect to form sound or colour However this may be I have given in my *Descent of Man* instances of closely allied birds inhabiting d + rie. of

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probability to the action of sexual selection

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